# DETERMINATION OF ALLOWABLE ANNUAL TIMBER CUT ON FORTY-TWO WESTERN NATIONAL FORESTS

An Analysis of Objectives, Problems, and Methods
with Recommendations

REPORT OF THE BOARD OF REVIEW
Forest Service
U. S. Department of Agriculture

Kenneth P. Davis, Chairman
Philip A. Briegleb
John Fedkiw
Lewis R. Grosenbaugh

September 3, 1962

## Chief's Comments

The enclosed report was prepared by a Board of Review which was appointed to examine the timber management planning procedures and progress of the Forest Service, U. S. D. A. Current stumpage demand equals or exceeds the total supply available from 42 National Forests in Region 6 and parts of Regions 1, 4, and 5. Here we consider it essential to maintain cutting at maximum sustainable rates. Hence we asked the Board to give special consideration to this area.

As shown by the tabulations which the Board made, the rate of cutting on this group of forests has been increased substantially and consistently as new and more reliable planning information has become available. Some relatively small additional increases will be made prior to October 15, 1962. Following this date, cutting rate increases will depend almost entirely on the increasing ability of the timber industry profitably to remove and use currently unregulated material.

The tabulations also show that cutting has been at the planned rate on this group of forests for some years now. Such tabulations may obscure local problems. On the other hand, general averages which include forests with allowable cuts in excess of demand, obscure the good record of this area where both allowable and actual rates are significant.

The topics covered in the review are indicated by the titles of the sixteen recommendations. These cover three general fields: Cutting rates (Recommendations 1 - 4, 10 - 12); measurement problems (Recommendations 5 - 9); and administrative problems (Recommendations 13 - 16). The following specific comments are by these groupings.

Cutting rates are influenced profoundly by future utilization goals and assumptions, the timber economy, the method and level of road financing, and, to a lesser extent, the size of regulated units. The first four recommendations are concerned with these factors. As recommended we intend to continue our policy of relatively large working circles and to work toward adequate road financing. Additionally, increasing attention must be given to opportunities to provide positive margins to low value material through avoidance of road overdesign and use of stage construction where applicable.

The Division of Forest Economics Research in cooperation with the Division of Timber Management will consider the feasibility of the Board's recommendation for expansion of work on economic studies of the impacts of alternative cutting level schedules.

The recommendation (No. 4) that timber management goals include definition of tree diameters and grades for final harvest cuts to be made after the conversion of over-rotation age timber has limited

application. It will clarify the implications of rotation age decisions for Regions to indicate in their Handbook guide lines the sizes and timber quality which are expected to be attained at the felling ages used in calculations of allowable cut. However, such size and quality estimates will not be used as the basic assumptions for rotation age determinations. Forest Service policy has been and will continue to be the use of age at culmination of mean annual increment as the primary consideration in determination of the rotation in allowable cut calculations.

Recommendation 10 concerns progress toward more intensive utilization. This is the major possibility for further increases in allowable cutting rates. Significant further progress is dependent upon both industry and Forest Service action. When problems are solved so that material which now has marginal and intermittent value attains a value sufficient to insure stable market demand, it will be included in allowable cut determinations.

The Western Forest Experiment Stations, working with the administrative Regions, will give high priority to studies of regeneration periods on National Forest timber sale areas.

On special landscape management and related areas where modifications of normal commercial cutting practices must be used the systems for establishment of average rates of cutting included in Recommendation 12, will generally be employed. They are being used for the current allowable cut redetermination for the 42 National Forests. Special situations may make use of other procedures advisable.

National Forest inventory work was intensified in 1957. The needs for further intensification, including the need to revise or supplement Forest Survey procedures to obtain maximum suitability for management planning purposes are stated in Recommendations 5 and 9. These recommendations are in accord with the orientation, policies, and programs now in effect for the conduct of timber inventories.

At the end of 1961 permanent locations for growth and mortality measurement had been established on 76% of the commercial forest area of the National Forests. These installations should be virtually completed within another year or two. This will permit rapid progress both on growth measurements and on growth prediction techniques (Recommendation 5, 6). Such inaccuracies as may still exist in established working circle cuts are most likely attributable to the growth predictions.

In the Douglas-fir subregion there have been serious problems associated with methods of product measurement and control. While less serious elsewhere, inefficient units of measurement have caused

difficulties in plans and sales. One means to overcome an important segment of such difficulties is the use of sample tree measurement in timber sales (Recommendation 7). Western Regions will test sample tree measurement on a scale adequate to determine its practicability.

Recommendation 8 is concerned with basic reform in the measurement of timber in the round. This is a far reaching, long range consideration. There is no question of the need for such fundamental reform. The pioneering research in this field now underway is a first step toward increasing attention to these basic measurement problems. However, an early change in sale units, as a result of this work, is not anticipated.

The last four recommendations concern such administrative matters as the tenure and experience of our personnel and the effectiveness of our communication with timber users, including our presentation of cutting rates and accounting for progress under them. While these items are not concerned with technical problems of allowable cut determination, it is clearly evident they must be given adequate attention in order to avoid misunderstandings and unnecessary controversies.

Changes in the allowable cuts in the 42 Forest area will be announced in the Secretary of Agriculture's report to the President by or before October 15.

The thoroughly objective and practical manner in which the Board of Review examined the problems before it is evident in the report. I wish to express appreciation to each member for a well done job.

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THE UNIVERSITY OF MICHIGAN
School of Natural Resources

Department of Forestry Ann Arbor

September 4, 1962

Mr. Edward P. Cliff, Chief
U. S. Forest Service
Washington 25, D. C.

Dear Mr. Cliff:

This is to transmit the report of the Board of Review on determination of the allowable annual timber cut on forty-two western national forests. Each member of the Board had, and carried, an indispensable part in the assignment. The report is truly a joint product.

Sincerely yours,

/s/

Kenneth P. Davis
Chairman

M-1299

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# DETERMINATION OF ALLOWABLE ANNUAL TIMBER CUT ON FORTY-TWO WESTERN NATIONAL FORESTS

An Analysis of Objectives, Problems, and Methods with Recommendations

## INTRODUCTION

This is the report of the Board of Review established by the Chief of the Forest Service, U. S. Department of Agriculture, July 6, 1962, in furtherance of a statement made by Chief Edward P. Cliff to the Senate Commerce Committee on June 18.

The composition of the Board is as follows:

Kenneth P. Davis, Chairman. Professor of Forest Management, and Chairman of the Department of Forestry, The University of Michigan

Philip A. Briegleb, Director. Southern Forest Experiment Station, Forest Service, U. S. Department of Agriculture, New Orleans, Louisiana

John Fedkiw, Chief of the Branch of Production Economics Research, Division of Forest Economics and Marketing Research, Forest Service, U. S. Department of Agriculture, Washington, D. C.

Lewis R. Grosenbaugh, Pioneering Research in Forest Mensuration Pacific Southwest Forest Experiment Station, Forest Service, U. S. Department of Agriculture, Berkeley, California

The general assignment of the Board is given by the Chief of the Forest Service: "Broadly expressed, the subject matter for consideration of the Board is policy, procedure, and practical application to specific working circles of any consideration which affects determination of allowable annual cutting rates." It was also understood that the Board should:

1. "Confine policy consideration to those consonant with the Multiple Use--Sustained Yield Act of June 12, 1960 (P.L. 86-517).

2. Exclude from consideration issues over policy or status of formally classified areas such as wilderness, wild, etc.

3. Exclude from consideration timber sale programming problems or timber sale policies."

Working within this framework, the Board had complete cooperation from the Forest Service in consultation with individuals in the organization and in access to data. It also had full freedom to consult with other concerned persons and organizations, and to develop its report.

The Board reviewed a large mass of written material including a number of timber management and multiple-use plans. It did not attempt individual analysis of 115 existing working circle plans including 39,133,000 acres of commercial forest land on 42 national forests. Rather, the purpose of the Board has been to concentrate its efforts on major situations, problems, and principles of general application.

The 42 western national forests, on which primary attention is centered, were designated as representing those on which timber demand-supply relationships are critical, making determination of allowable cuts of particular importance. These forests are in western Montana, northern and southeastern Idaho, Washington, Oregon, and California. They are located in Forest Service Regions 1, 4, 5, and 6. These forests are named and statistics concerning their present commercial forest area, and past and present allowable annual cut and actual cut, are given in Summary Tables 1 and 2 included at the end of this report.

This report was prepared as a result of two weeks of consultation, analysis, and writing in Portland, Oregon. It was initially intended to circulate a draft of the report for general review by Forest Service and other concerned people for 60 days. However, a commitment by the Secretary of Agriculture to report by October 15 on increased allowable cuts on these forests, based on current adjustments and recomputation from latest inventory data and some changes in procedures, made it necessary to complete the report in much shorter time, with very limited opportunity for the Board to obtain review.

Those consulted by the Board were as follows:

U. S. Forest Service, representatives of the Washington Office and Regions 1, 4, 5, and 6, and the Pacific Northwest Forest and Range Experiment Station.

Bureau of Land Management, Mr. Travis Tyrrell and Mr. Rodney O'Fety, Portland

Bureau of Indian Affairs, Mr. Earle Wilcox, Area Forester, Portland

Western Forest Industries Association, Mr. Joseph W. McCracken and associates

Industrial Forestry Association, Mr. William D. Hagenstein and representatives of four association members

Western Pine Association, Mr. Ernest L. Kolbe

Western Lumber Manufacturers' Association, Inc., Mr. George R. Craig

# NATIONAL FORESTS IN THE WESTERN ECONOMY--1962

The western national forests of Washington, Oregon, California, Idaho, and Montana now provide more than 30 percent of the timber supply of the forest industries of these states. Their role in the economy of these states has changed rapidly and drastically during the decade of the 1950's. At the beginning of the decade their total timber harvest had just passed 3 billion board feet, a little more than 15 percent of the industrial timber supply. In the late 1950's the national forest harvest averaged more than 6 billion board feet, somewhat more than 30 percent of the industrial timber requirements. In the next decade this proportion will increase even further.

The dynamic role of national forests arises from two trends. First is the growth of the western forest industries in the decade of the 1950's. Western lumber output expanded from 17 billion board feet in the late 1940's to more than 20 billion board feet in the late 1950's and 1960. Plywood output more than quadrupled between 1948 and 1961, increasing from 2.0 billion square feet to 8.4 billion square feet. Pulp production nearly doubled, increasing from 2.5 million tons in 1950 to 4.6 million tons in 1961. 1/ The western forest industries grew with the national economy during the 1950's. The basis of much of that growth came from fuller development of the timber harvest potential of national forests.

The second factor in the expansion of national forest timber harvests has been the need for evening-out the timber supply of established industries and stabilizing communities as the private timber harvest has declined. This was particularly true in Washington and Oregon where the forest industries were more highly developed at the end of World War II. In the Douglas-fir subregion, for example, total log production between 1947 and 1960 averaged 10.9 billion board feet with a relatively small average annual deviation of 7 percent or 756 million board feet. Log production from public lands in the same period, on the other hand, increased from less than 25 percent to 38 percent of the total output. Log production from national forests in western Washington increased from about 300 million board feet to 600 million feet, and in western Oregon from approximately 700 million feet to 1,700 million feet.

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1/ Pulp expansion came largely from fuller use of the log output; through utilization of plywood and sawmill residues and chips rather than direct increases in log consumption.

The Douglas-fir subregion has not been free from the general economic pressure for expansion. The plywood industry increased its installed capacity from 2.2 million square feet to 9.2 million square feet between 1947 and 1960. This came about at the expense of lumber capacity, for the expansion of the public log harvest was not sufficient both to meet the growth demand of the plywood industry and to maintain the lumber capacity and output of the subregion. In 1950 the plywood industry utilized only 10 percent of the subregion's total log production. Currently, its requirements approach 30 percent of total log production. For its expansion the plywood industry has had to bid its timber supply away from the lumber industry. As a consequence, estimated lumber capacity in the subregion declined approximately 2 billion feet in the past decade with nearly as great a decline in lumber output. Expansion of lumber capacity elsewhere in the western states, however, has not only offset the decline in the Douglas-fir subregion, but provided for about 3 billion feet of expansion in output, primarily on species which compete and substitute for those of the Douglas-fir subregion.

Capacity and output of the western forest industries during the 1950's expanded more than the economic demand. Some unused capacity and overproduction has tended to follow along with softening of prices and a downward pressure on profits. Lumber prices through the 1950's remained relatively stable and plywood prices dropped sharply. Their real prices declined relative to competing materials, improving the competitive strength of wood products, but not without the downward pressure on profits.

Stumpage prices rose sharply in the early postwar period and maintained a high level through the 1950's tending to emphasize the profit squeeze in the late 1950's. Another factor which has tended to complicate the problems of the lumber industry in the most recent years has been the ability of Canadian producers to expand significantly their share of the American lumber market.

Under the competitive circumstances and somewhat depressed profits of recent years, the planned timber harvest from national forests has come under increasingly critical scrutiny. Earlier demands for expanding the national forest harvest to its full potential appear to arise largely from expansion of capacity and maintenance of a stable flow of logs for established industrial communities. The more recent pressure seems to arise from a wish to increase the public log harvest in the hope of depressing stumpage prices and manufacturing costs to partially overcome the cost advantage now possessed by Canadian lumber producers.

In the past decade, the log supply from national forest lands has become a primary factor in the economic life of the western forest industries. Decisions on national forest timber harvest now involve nearly a third of the industrial log capacity. As private sources of supply continue to decline in the next several decades and inter-regional and international competition for American wood products markets continues to develop, national forest management decisions on the level and character of its timber harvest will have increasing economic significance in determining the size, structure, location and capacity of the western forest industries.

The situation dictates a need for a thorough understanding of the major economic role that national forest timber management planning now plays in the economic life of the western economy generally and western forest industries particularly. The full harvest potential and its optimum distribution over time should be studied even though the ultimate decisions must be based on existing policies and legislation which prescribe attaining maximum yield and better balance of age classes with a reasonably even flow of products looking toward an ultimate crop of trees of sawtimber size and quality (and other crops where soil and site preclude sawtimber production).

## WESTERN NATIONAL FOREST MANAGEMENT SITUATION

The total commercial forest area on 42 western national forests in Washington, Oregon, California, Idaho, and Montana is currently estimated at 39,133,000 acres. Approximately six percent has been placed in a modified timber use category and will be subject to some restrictions due to multiple-use considerations. Indications are that this percentage will be increased further.

The present inventory is estimated at 639 billion board feet with approximately eight percent falling within zones classified as requiring modified timber use. The current allowable cut is 7.16 billion board feet, or 1.1 percent of the total inventory and 1.2 percent of the inventory on the unmodified commercial forest area.

The management planning situation on national forests changed abruptly during World War II and thereafter, as the war effort and booming economy rapidly accelerated the demand for timber supply from national forests. In the prewar period the supply of national forest timber was of relatively small immediate economic significance in the western states. Markets were limited, and during the depression period of the 1930's sale of national forest timber was restricted in order to ameliorate the economic condition of the lumber industry. Accordingly, the allowable cut, for all practical purposes, was an academic question.

Generally speaking, the national forests were grossly underdeveloped and unable to meet the shift in demand for public timber after World War II. The general problem centered on inadequacies in the road systems, inventories, financing, and market forecasts. The major tasks in the period since World War II have been to develop more accurate inventories for planning the allowable cut and bringing it up to the full sustained-yield potential of national forests, to develop the access road system sufficiently to harvest the allowable cut, and to obtain the financing necessary to meet these objectives. The extent to which these tasks have been achieved are illustrated by Table 1.

Table 1. Relation of Allowable Cut to Actual Harvest, 42 Western National Forests, Fiscal Years 1952 - 1962.

| Fiscal Year | Allowable Cut | Actual Harvest 1/ | Harvest as a Percent of Allowable Cut |
|---|---|---|---|
| | Millions of Board Feet | | |
| 1952 | 4,383 | 2,863 | 65 |
| 1953 | 4,405 | 3,652 | 83 |
| 1954 | 4,714 | 3,707 | 79 |
| 1955 | 4,879 | 4,399 | 90 |
| 1956 | 5,000 | 4,707 | 94 |
| 1957 | 5,225 | 4,742 | 91 |
| 1958 | 5,783 | 4,422 | 76 |
| 1959 | 6,029 | 5,924 | 98 |
| 1960 | 6,163 | 6,877 | 112 |
| 1961 | 6,429 | 5,965 | 93 |
| 1962 | 6,651 | 6,694 | 101 |
| Current | 7,159 | - | - |

1/ Includes some timber harvested but not chargeable to the allowable cut.

The allowable cut estimate has been increased every year and continues to be increased as inventories are improved, utilization standards increased, working circles enlarged, and rotations shortened in accordance with judgments concerning the sustained-yield potential of the forests. As access roads have been developed, the actual cut has been gradually raised to the full allowable cut which is the objective. From 1952 to 1954 the actual harvest averaged 76 percent of the allowable cut. From 1955 to 1958 it was 87 percent, and since then it has averaged 100 percent.

During the past eight years the size of working circles for management planning and allowable cut calculation purposes has been increased substantially. The number of working circles is now 115 for the 42 western national forests, and will be reduced to about 70 as present working circles are further combined in Regions 5 and 6. A substantial number of working circles now include an entire national forest. The effect of larger working circles has been to reduce the sampling error in inventories and to improve the distribution of age classes in the planning unit. The latter change tends to give a larger allowable cut. Further expansion of the area grouped under a single allowable cut control would tend to raise the allowable cut to a higher level. The effect of such change can be examined and quantified in studying the harvest and management potential of national forests. The practical problems of implementing such changes, however, should be evaluated in conjunction with such examination. It must be recognized that the larger the working circle, the greater the pressure on and the importance of internal administration in the allocation and scheduling of the available cut.

Currently, management planning and national forest development are sufficiently advanced to keep the annual harvest abreast of the currently determined allowable cut. The principal tasks that lie ahead with respect to further refinement in determining the allowable cut are: Further improvements of inventories; better estimates of long-term sustained-yield potential as may be obtainable from better growth and yield data; integration of non-timber uses with timber management; and closer coordination of the species and grade mixtures on national forests with market developments in scheduling the conversion of the old-growth timber to well-stocked, managed second-growth forests.

The 42 western national forests are still primarily old-growth and over-mature forests with 50 to 70 percent of the stands older than established rotation age. The management task is one of conversion to a well-balanced second-growth forest capable of sustaining the long-term harvest potential, and at the same time, providing an optimum distribution of the old-growth harvest for the needs of the western forest industries.

There is timber harvest potential in addition to the allowable cut available from considerable portions of the gross growth in mature and overmature timber which is lost annually through mortality and decadence. An indication of the amount of loss involved is given in Table 2 which shows approximate mortality rates on public forest

lands in the Douglas-fir subregion of western Washington and western Oregon. Most of the public old-growth lands tabulated in Table 2 are on national forests. In addition to these estimated annual losses, there are substantial accumulations of salvage from past mortality in the old-growth forests. Other sources of additional timber are thinnings in younger stands and prelogging and sanitation harvests in older stands. Some of the timber volume from these partial harvests, particularly that from salvage, is now added to and therefore charged against the allowable cut. The remainder are available through application of management practices which increase the total net yield per acre for any given time period but do not decrease the major harvest cut and are not chargeable to the allowable cut. These sources should be made available as forest improvement harvests as rapidly as the forest industries can economically utilize the harvest material. This is already being done to a considerable extent in the ponderosa pine region. Pilot-scale tests are needed in the Douglas-fir region to develop feasibility of such cutting.

Table 2. Approximate Gross Growth Lost to Mortality, Douglas-fir Subregion a/

| Age Class | Approximate loss of gross growth in percent | Commercial forest area in public ownership, M acres |
|---|---|---|
| 40-100 | 15-30 | 2,574 |
| 101-160 | 30-60 | 1,257 |
| 161-300 | 50-90 | 2,731 |
| 301 + | 80-100 + | 1,311 |
| Total | | 7,873 |

a/ Adapted from Fedkiw, J., Advance Roading for Increased Utilization in the Douglas-fir Region of Oregon and Washington, presented at the 51st Western Forestry Conference, Victoria B. C., December 7-9, 1960.

Thinnings accelerate the diameter growth and capture the mortality in younger stands. They also make available for current harvest that portion of the growing stock which is unproductive and not needed to capture the full growth potential of the soil. Prelogging and sanitation cuts in older growth timber harvest the accumulated mortality and part of the green timber. Partial harvests of this sort in the Douglas-fir subregion take six to ten thousand board feet per acre. A quarter to a half is salvage. The balance is live timber, including high risk trees and small understory trees which are often broken up

or uneconomic to log in a single-stage clear-cut. Firms using these partial harvest methods claim about an eight percent increase in the total yield per acre over the single-stage clear-cuts.

These partial harvest operations are mentioned because they are the type of management practices which are needed to capture more completely the full growth and yield potential of national forests, and to bring the present timber stands closer to optimum growing and utilization conditions. Such harvests, however, are more sensitive to market fluctuations at the present than ordinary final clear-cut harvests. Generally, they are more economical and acceptable to operators when the timber market is rising or at a high level. Accordingly, the forest should be developed and plans readied to take advantage of the markets as they develop over time. Currently there is a general market trend toward acceptance of greater volumes of timber from partial harvest management operations. To take maximum advantage of future developments, the basic requirements are advance roads and stand classifications which locate and identify the opportunity for partial management harvests.

Currently, the national forest road systems are inadequately developed to permit capturing the maximum growth and yield potential upon which present management plans are based. The basic problem is partly a matter of a rather inefficient system of road financing and too low a level of advance road development. Table 3 shows the status of road development on national forests of Regions 1, 4, 5, and 6. Only about one-quarter of the total road system has been developed at a time when the full harvest potential of national forests is being called upon by the western forest economy.

Table 3. Status of Road Development on National Forests of Regions 1, 4, 5, and 6.[a/]

| Region | Estimated total mileage req. | Installed roads | Current annual rate of construction | Est. yrs. to complete road system | Estimated cost to complete road system |
|---|---|---|---|---|---|
| | miles | miles | miles | years | billions of dollars |
| 1 | 108,573 | 20,611 | 800 | 100 | $1.25 |
| 4 | | | | | |
| (Boise N.F.) | 11,790 | 2,215 | 125 | 77 | .13 |
| (Payette N.F.) | 7,785 | 1,265 | 60 | 109 | .07 |
| 5[b/] | 58,968 | 7,132[c/] | 643 | 75[d/] | .75[d/] |
| 6 | 76,860 | 29,469 | 1,600 | 30 | 1.3 |

a/ Based on correspondence from respective Regions in August, 1962.
b/ As of 1958.
c/ Excludes 18,491 miles of unsatisfactory road.
d/ Includes rebuilding of 18,491 miles of unsatisfactory road.

The present method of financing the development of the road system has several disadvantages which adversely affect timber yields and the productivity of the capital represented by the national forest timber resource. Tying road financing to timber sale contracts essentially precludes any substantial amount of road construction to open up young stands for thinning. Where there are substantial areas of medium-aged timber, 80-150 years old, present policy tends to force premature harvesting of a considerable portion of the area of such stands in order to open them up for management. On the other hand, some areas of accessible but less productive and decadent timber stands have to be left behind in order to extend the road system into undeveloped lands. Where the oldest and most decadent stands are remote from established access, the present policy defers their harvest until they can be reached by progressive staggered cuttings through the intervening timber. Finally, the system sometimes forces forest managers to allocate allowable cut to stands which are less adapted with respect to species, grades and location to meeting current needs of the timber industry, particularly when forest product markets are unfavorable. Generally the present road financing arrangements force land managers to use the allowable cut to develop the road system, whereas roads ought to be financed in a way that will develop the optimum allocation of the allowable cut and achieve the maximum harvest potential of national forests.

The most fundamental change needed to attain this potential is a financing arrangement which makes roads a means or tool for planning and development rather than an objective of the allowable cut.

## FOREST INVENTORIES--NEEDS, PROBLEMS AND USES

### General

Information on current inventory of timber stands on the forty-two western national forests under consideration constitutes the primary base from which all allowable cut calculations start. Different objectives or different assumptions as to the future may lead to radically different allowable cuts, but they should rest on a common factual inventory base.

There are four main types of inventory sampling vital to intensive or dynamic management of any forested property.

First is a relatively light but to some degree permanent sample of current tree sizes, species, and volumes by various tree and area classifications, such that present structure of the forest is specified and sampled and that remeasurement of identical trees and areas in the future will permit efficient assessment of rate and direction of future changes that can only be guessed initially. Such an inventory involves semi-permanent plots, lines, or sample points that facilitate associating measurement of each sample tree with its subsequent remeasurement.

Second is a less complex but more intensive ground-sample of each individual logging chance to get simple quantitative information on the location, accessibility, feasibility, and relative priority of alternative action programs such as salvage cutting, partial cutting (weeding, thinning, risk, sanitation), and regeneration measures.

Third is a detailed cumulative inventory of sample trees marked for harvest, trees actually felled, or residues representing trees harvested, dead, or missing. Intensity of this sampling should be appropriate to number, value, and variability of trees or logs harvested.

Fourth is the inventory relating measurable elements of standing trees to actual manufactured yield of lumber, plywood, poles, chips, etc. This must be kept up-to-date and representative of both existing tree populations and existing utilization practices, and is needed for sales appraisals, estimates of material lost through hidden defect, and estimates of change in economically recoverable wood volume that can be made available from inventory.

Each of these inventories is discussed below.

## Extensive Management Plan Inventories and Growth Samples

Although management plan inventories of the first type have been available in primitive form for many years on most of the forty-two national forests, it is only in the last five or six years that prospects for more access roads and better markets rendered up-to-date management plan cruises with relocatable semi-permanent samples a necessity. The bulk of the forty-two forests now have such inventories although they have not been completed on a few forests. Periodic revisions of all plans in the next ten years will require remeasurement of a relatively small number of semi-permanent sample trees and reproduction areas.

For the most part, such *ad hoc* management-plan inventories are correlated with Regional Forest Survey techniques, though they tend to be more intensive and may obtain information in addition to that required by Forest Survey. Information is so far superior to that previously available that praise rather than criticism is in order. However, it should be noted that in coordinating with Forest Survey, compromises were made on points which weaken the overall value of the information for management planning purposes. These include arbitrary definitions of commercial forest land and adequacy of stocking, use of field classifications, types, and averages instead of individual field measurements, occasional lapses into continuing instead of periodic inventories, insistence on a 1-acre cluster instead of some more efficient sample size, failure to employ silviculturally meaningful angle-gauge sizes, and gearing survey design to photo-volume stratification that cannot possibly provide most of the needed silvicultural information on species, tree class, stand structure, growth, and operability.

For the plans resulting from the new and improved inventories, of course, change information from the new semi-permanent samples is not yet available. A few forests have been able to remeasure permanent

plots established in partial cuttings a number of years ago, but this provides only a coarse measure of periodic growth for a small and extremely variable portion of the forest and is ill-adapted to intensive structural analysis. In the years to come, changes in growth and mortality attributable to more intensive management should be detectable in the permanent samples long before they can be detected by successive independent inventories. These semi-permanent samples should primarily be regarded as measuring survivor growth, ingrowth, and mortality by various tree classes rather than furnishing accurate inventories for budgeting sales.

Although the new extensive inventories of the type just discussed are invaluable for assessing growth and change, the total volumes they predict as available for harvest will usually be over-estimates and do not pin-point location of operable areas. There are a number of reasons for this. The most obvious is that ground samples frequently fall in small areas where densities may appear operable, but the larger logging chance in which they lie is inoperable because of low density of cut, rough terrain, erodability, or the nebulous but real caution imposed by loosely specified multiple-use restrictions. Photo stratification, of course, is subject to large local errors in volume per acre and even greater errors where the characteristics of trees comprising the volume are important.

## Intensive Area-by-Area Inventories For Allocating Harvests and Other Treatments

The second kind of inventory mentioned involves examining individual operating units on the ground and recording enough data about the land and timber (tallying sample trees at a few points so as to get a reasonable estimate of volumes per acre by tree-class). From this the unit's operability, relative silvicultural needs, etc., can be deduced. Where intensive management is feasible now, a truly diagnostic tally is desirable for every logging unit on the forest at least every ten years. Something less than that might be adequate in these forty-two western forests involving large amounts of over-mature timber. As a minimum, all areas now accessible to roads and all areas that have undergone at least one cut should be so inventoried, plus enough additional inventories to provide realistic allocation of cutting budgets and adjustment of total inventory figures to an operable base. Estimation of the proportion of overall commercial forest area and volume that is unavailable because of inoperability must come from relating these intensive area-by-area examinations to the much more detailed but less operationally meaningful figures derived from photo-interpretation with widely scattered ground-samples. However this matter is handled, it should be done in a clearly specified, plan-wise manner, not by some hard-to-explain discount factor whose subjectivity and ex post facto nature breed suspicion. Not much inventory of this sort appears to be available on most of the forty-two forests reviewed, with the result that there is no clear picture of what is both silviculturally desirable and economically feasible now.

## Inventories for Control Purposes (Timber Sales and Other Depletion)

The third kind of inventory is intended to measure or sample the trees removed from the stand, and to serve as a basis for payment when the removal is in the form of a timber sale.

All depletion must be converted to the same basis used in measuring the standing tree inventory of which it once was a part. This creates special problems in two situations:

1. Where no measurement of the standing tree can be secured prior to removal, and where only residues (stump, top, etc.) are available for measurement, as in the case of trespass, logging damage, or damage from various types of construction. Special hypotheses relating missing stem measurements to residue characteristics must be locally devised, and resulting estimates are crude at best. As with the problem of non-respondents in mail surveys, there is no completely satisfactory solution to this problem, but it usually does not involve important amounts of timber.

2. Where major portions of felled trees are scaled in the form of logs. Special provision must be made for validly sampling and measuring some marked trees prior to felling, so that scaled volume can be converted to standing tree volume, including appropriate allowance for peculiarities of a wide variety of scaling practices, volume tables, deductions for breakage, and logging residues.

This problem is particularly aggravated in the Douglas-fir region where various scaling and grading practices are employed by the Forest Service and outside agencies. Arbitrary assessment or neglect of taper, measurement of narrow rather than average diameters, and disregard of fractional inches have destroyed any consistent relationship with standing tree measurements. This chaotic situation will not be discussed at length, but it is certainly responsible for much misunderstanding, dissatisfaction, and expensive reconciliation procedures. Differences as great as plus or minus 25 percent in the numerical volume assigned to a given felled tree are not uncommon, depending on what kind of a "board foot" scale was used, how much taper was neglected, and what was done about non-circularity or fractional inches. Occurrence of such discrepant inventories tends to undermine successful implementation of timber management plans.

A more efficient solution to the second situation (i.e., where an inventory of timber harvest is needed both as a basis for depletion and as a basis for sale) is believed to be sample tree measurement. This is discussed at some length in a later section under "Units of Measure." Subsamples of percent bark, percent hidden defect, and percent logging waste can be obtained for appraisal purposes. Whether or not this method is adopted for sales, the possibility of doing so with modern techniques (i.e., good sampling designs, optical

dendrometers, electronic computers, and better units of measure than ambiguous board feet) should be investigated for the forty-two national forests involved. The practical experience of the Bureau of Land Management in the West and the Forest Service Region 8 in the South should be analyzed carefully, and the participation of research personnel should be encouraged.

If adopted, there is no doubt that sample tree measurement in the West will be cheaper than 100 percent log scaling. It will also provide more accurate measurement of tree depletion by class of tree involved (poor risk, mortality, overmature, etc.) and will provide additive measures that can be more accurately related to various end-product yields under various assumptions as to utilization standards or efficiency of manufacture. Inventory procedures to secure such information will be the next item discussed.

## Inventories for Estimation of Product Out-turn from Trees or Logs

The fourth type of inventory needed in management involves sampling the product out-turn (including bark, defect, etc.) from the inventory taken in the third step discussed above. The usual mill scale study for appraisal purposes is an example. Although the forty-two forests under consideration may have obtained an adequate set of inventory conversion factors, it must be remembered that changes in marked tree or log scale inventory procedures or measurement units, changes in utilization practice, and changes in the type of timber marketed require that the factors be continuously up-dated. Batch yields from graded groups of logs or trees (instead of more expensive individual tree or log yields) will frequently be adequate, however.

## Units of Measurement

Discussion of the four preceding types of inventory has assumed for the most part that primary units of measure and variables measured were universally agreed upon and satisfactory. Actually, this is far from the true situation. Not only are the units now used unsatisfactory and controversial, but there is considerable diversity of opinion as to alternatives which might be better.

Although this is far from an academic problem, an academic approach might eliminate some misunderstanding and heated controversy. Enlightened forest management is being seriously hamstrung by clinging to inefficient units of measure that convey less information than alternative units or that are so ambiguous that they hardly deserve to be called "units of measure." The cord and the board foot applied to round wood suffer from both weaknesses.

In science, a scale should be composed of units of measure that are unambiguous, consistent, simple in application, and additive--adjectives corresponding to specificity, reproducibility, simplicity, and linearity.

A board-foot unit has these attributes when applied to lumber sawed precisely one inch in thickness, but not when applied to lumber of

other thicknesses or to logs. How much loss due to trim, slab, edgings, and kerf does it assume when applied to logs of different size? What minimum board size and thickness is assumed? What is the assumed gain in yield attributable to taper in logs of different length and diameter? What are the effects of non-circularity, visible defects, and invisible defects?

All of the above ambiguities plus additional ones are present when the board foot is used as a unit of measurement for trees. What assumptions are made as to bark thickness and taper in the upper stem (the volume table dilemma)? What log length is assumed? What assumption is made as to cessation of lumber manufacture in the upper stem?

From this, it is easy to see why the board foot is such an ambiguous unit that nearly a page of text is needed partially to remedy its lack of specificity. After 200 years, the proliferation of board-foot definitions has become ludicrous and has imposed a massive conversion job on anyone who really would like to derive any usable information from either scaled or cruised volumes in relation to possible product yields.

Partially as a result, measurements in board feet are not consistent or reproducible when the same trees or logs are measured by different individuals, or by the same individuals under different circumstances. The illogic of letting bucking practices affect inventory volumes by ignoring more or less taper as logs are cut longer or shorter is obvious. The illogic of guessing at breakage and unseen defect is not so apparent, but just as real. These should be estimated by subsampling and taken into account by the seller and purchaser in their appraisals and bids, just as grade and lumber recovery are.

Lack of simplicity in application is indicated by the numerous handbooks, manuals, and texts--each trying to explain differing methodology and each lending support to the conclusion that board foot scaling is more of a craft than an objective system for scientifically measuring something that exists independent of the scaler's imagination.

Finally, to complete the miserable picture, the log or tree board foot lacks linearity because overrun differs by log or tree size. Hence, board feet from trees or logs of different sizes cannot be added together without destroying any consistent relationship between scale and lumber yield for a given mill operating according to standard practice.

The cubic foot <u>per se</u> has only a slight advantage over the board foot in that no ambiguous deduction for kerf, slab, edging, and trim has been made, so it is not quite so difficult to relate it to yields of non-sawed products. Unfortunately, the product yields per cubic foot depend on diameter and assumed taper just as in the case of the board foot.

A simple solution to the problem of units of measure is available. Accurate sample tree measurements of tree diameters outside bark at known heights (using dendrometers and computers) yield estimates of

cubic volume, circumferential surface, and grade outside bark for tree sections whose length is also known. Portions of the upper stem beyond any currently feasible utilization limits may be included if changing utilization standards are of interest. Bark and defect can be subsampled by the fourth type of inventory discussed earlier.

Rather than using merely the cubic foot alone as a unit of measure, it is preferable to use cubic feet, square feet of circumferential surface, and linear feet. This trio of measurements, accumulated separately, will allow conversion to lumber yields, fiber yields, plywood yields, etc., much more consistently and accurately than either board feet or cubic feet alone. For instance, International 1/4-inch board feet can be easily derived as 9.12 $\sum$ cu. ft. - .71 $\sum$ sq. ft. + .04 $\sum$ linear ft. Board feet could not have been derived from aggregate cubic feet alone without knowing what sizes of trees comprised the aggregate volume, nor could aggregate cubic feet have been accurately derived from board feet alone.

Felled timber can similarly have measured diameters and lengths automatically converted to cubic feet, square feet of surface, and linear feet. Units of measurement should ordinarily include bark because that is what is directly measurable in standing timber (note standard acceptance of outside bark basal area and d.b.h. measurement). Bark, defect, and product yield obtained from subsampling should be taken into account in product yield conversions such as are needed in appraisals and bidding, but should not be allowed to contaminate basic tree measurements. This does not mean that inventories cannot be converted to as many different types of units as are desirable. Total weight, moisture percent, dry-wood specific gravity, etc., may be desirable in estimating certain product yields, but they can always be related to volume, surface, and length. In certain situations, such as yard or jackladder inventory, it may be more efficient to measure weight and linear feet of all or part of the felled trees, but these can be related to standing tree volume, surface, and length based on a much smaller sample.

All in all, it seems that adoption of more informative, less ambiguous primary measurement units such as cubic feet, square feet, and linear feet in place of board feet will be desirable in the near future or else management planning and sales will bog down in a morass of unnecessary mensurational difficulties. The fact that lumber standards already deviate so far from the nominal one-inch standard lumber thickness (and may soon deviate more) indicates a real need to divorce manufacturing practice from primary units of measurement used in inventory.

## Prediction of Inventory Change (Especially Growth and Mortality)

Inventory change is the algebraic sum of survivor growth, ingrowth from trees below inventory limits, mortality, planned harvest, damage from various sources, and trespass. Ordinarily, depletion items such as planned harvest and logging damage are best measured by special inventories for control purposes discussed earlier, while growth of all sorts and normal mortality are measured on semi-permanent

samples also discussed earlier. Until this latter information is available, growth must be estimated from yield tables, and its accuracy or applicability cannot now be assessed. Remeasurement of the semi-permanent samples unfortunately is still 5 to 10 years away.

Certainly the number and quality of normal yield tables available in the 42 western national forests exceeds that of most other areas in the United States. The major question is how to handle stands which are not normal (some partially cut) now found on the bulk of the forested acreage, and how to handle the variety of situations which will probably be deliberately achieved under intensive management. Although adjusted normal yield tables or other empirical yield tables may serve for first estimates of growth, their assumptions become intolerable after one or more growth periods have elapsed and permanent sample remeasurements are available. But unless systematic plans are made soon to incorporate growth information from permanent samples into growth predictions and allowable cut calculations, the samples will not contribute as much to management planning as they should and an opportunity to demonstrate both professional skill and freedom from subjective bias will be lost.

There are four major approaches to using permanent samples to adjust allowable cut at the end of a planning period.

First, remeasurement of the samples may merely furnish a new inventory base for the start of the next regulatory period. Other things being equal, allowable cut will then tend to rise if inventory exceeds that which would have existed had initial assumptions as to growth been exactly borne out, or fall if inventory is less than expectation. Use of permanent samples in this manner does not justify their high cost, since two successive independent inventories would have been cheaper and more satisfactory.

Second, age-class growth experience graphs can be built up for subsequent use with the familiar tabular area-volume check of periodic growth with periodic cut. Such experience graphs will replace the normal or empirical yield tables and can better take into account actual site, actual density, and prior history. However, a long time must elapse until enough data are available to extend them the entire length of the rotation, and they must be subjectively fitted with almost as much strong-arming as in the case of empirical yield tables.

Third, net or gross growth percents, for initially different tree classes in the permanent samples may be used for short-term projections of the terminal tree classes. Although this method is often thought of as being especially adapted to uneven-aged management, it is equally useful in even-aged management. It has less appeal where the bulk of the stand is static old growth, but can be used even there if partial cuts are intelligently allocated to second-growth stands. The main problem is to ensure that the volume of allowable cut is taken from old-growth stands most in need of being harvested and regenerated, and from components of second-growth stands when such removal will either reduce loss from mortality or stimulate growth of residual stems.

Fourth, nonlinear functions employing measurable elements of stand structure to calculate stand development (but with arbitrary parameters) may be used to predict growth of permanent samples. Actual deviation from predictions will feed back to generate more realistic estimates of parameters which are then used to predict growth for the subsequent period. The effects of expected weather difference may be analyzed if desired. This is probably the most efficient use of permanent growth samples. Since yield tables have no explicit provisions for predicting change due to heterogeneity in density, age, or size, they cannot be used in this way. Ordinary multiple linear regression analysis is a crude form of the structural approach, as are techniques concerned only with projection of diameter distributions. It is to be hoped that research underway in several places will lead to better methodology than is now available.

One or more of the four methods outlined above should be selected before remeasurement of the semi-permanent samples. In the likely event that any but the first is chosen, the method of prediction used in the current management plan should be applied to each semi-permanent sample to permit later assessment of whether assumptions underlying the method were overly optimistic or overly conservative.

## ALLOWABLE ANNUAL CUT DETERMINATION--OBJECTIVES, PROBLEMS, AND PROCEDURES

### Nature and Objectives of Allowable Cut Determination

The renewable resources of the national forests are traditionally managed under a policy of sustained yield. Regulation S-3 requires that timber resources be managed for the greatest lasting benefit to the country and to the end that the permanence of yield and usefulness of these resources will be assured. S-3 recognizes that orderly harvesting of timber by methods, at rates and at the proper time to provide a continuous yield is an essential management objective.

In addition, the Multiple Use-Sustained Yield Act of June 12, 1960, has since required, by Congressional and Presidential direction, the maintenance of national forest productivity to insure perpetual optimum-level annual or regular periodic output of the various renewable resources. Forest Service policy, as given in the Timber Management Manual, recognizes that optimum levels of forest product yields will vary with markets, total use needs, and current working circle conditions. The Manual states that generally the output should increase as wild forests approach an organized condition and the intensity of management is increased. Management must be such that large, sharp, or long sustained decreases in yield do not occur except as the possible result of unforeseen catastrophes. Minor temporary yield depressions may be permitted if insuperable losses are prevented thereby.

Timber cutting policy for the national forests is further described by Chief Cliff in his May 7, 1962, memorandum to Secretary Freeman, Proposal Number 1:

> "The Forest Service shall develop an orderly program of timber sales designed to obtain regular harvest from commercial forest areas of the National Forests on a full sustained-yield basis in accordance with policies established for multiple-use management and protection of National Forest resources. Attainment of this objective in annual timber sale programs must necessarily depend on the finances available, local market demand for stumpage and adequacy of transportation facilities."

It is Forest Service policy to manage each working circle for the production of crops of sawtimber size and quality from all suitable forest types and sites, unless exceptions are approved for a particular working circle or part thereof. It is policy also to produce other products (such as pulpwood, posts and poles), (1) from intermediate cuts wherever practical in conjunction with sawtimber production, (2) from trees and parts of trees below saw log size or quality on areas of regeneration cutting, (3) from forest types and sites on which it is not practicable to produce continuous crops of sawtimber size or quality.

In the broad sense, allowable cut under sustained yield management is the average volume that may be harvested annually during a planned period of operation from a given forest unit, which will result in a sustained yield of timber products and the eventual attainment and perpetuation of an approximately balanced distribution of tree age or size classes and desirable stocking. Sustained yield capacity is the highest uniform yield that may be sustained on a given forest unit under a specified intensity of management and with a balanced distribution of timber age or size classes. Management for sustained yield implies continuous production with the aim of achieving, as soon as practical, a balance between net timber growth and harvest by annual or somewhat longer periods. Allowable cut is synonymous with sustained yield capacity when the balance of timber age or size classes and the balance between growth and harvest are achieved.

On the western national forests, characterized by wide variations in timber merchantability, accessibility, markets and operating conditions, the term "allowable cut" is used in a specialized sense. Here the allowable cut is the timber volume, for which there is assumed to be a reasonably active and steady market, that may be harvested annually during a planned period of operation, and which will result in a reasonably uniform sustained yield of timber products and the eventual attainment and perpetuation of a balanced distribution of tree ages or sizes and desirable stocking.

Most western working circles contain timber of marginal merchantability or accessibility under current operating conditions that is not included in the designated allowable cut. Working plans show the volume of this material that is available for harvest as an addition

to that included in the allowable cut. This material is variously referred to as "supplementary available cut," "additional cutting objectives," or "unbudgeted cut." Included in this category, for example, is the estimated annual volume of tree mortality in Douglas-fir region forests, potential thinnings, volumes in alder and other hardwoods, volumes in marginal lodgepole pine stands and of timber on very steep or unstable soils not loggable by current methods without causing intolerable erosion.

Theoretically, such timber will be available for cutting if and when active markets and acceptable operating methods are developed for it. Minor amounts of this timber have been harvested in the past, but its contribution to the economy is sporadic and undependable. It would be unrealistic and confusing to include such volume in the formally designated and regulated allowable cut. The national forests are trying to develop active markets for this marginal material, and as reasonably steady demands for it may be realized, this additional volume will then be logically included in the allowable cut.

The Board believes that the Forest Service should continue and strengthen its efforts to develop uses and operating methods that will increase the value of this marginal timber as an economic industrial raw material. This represents an opportunity to increase the allowable cut, and to reduce the misunderstandings about allowable cut figures and the supplementary cuts possible when conditions permit on the national forests.

The technical objectives of sustained yield timber management are:

1. To obtain the maximum yield of timber products possible.

2. To provide for an essentially uniform yield of timber products.

3. To attain or perpetuate a balanced distribution of tree age or size classes and desirable stocking capable of producing the forest's full potential timber growth.

These three objectives are simultaneously attainable only in a so-called fully-regulated forest with a balanced growing stock; they are not all immediately attainable in such wild forests in the beginning stages of management as characterize the western national forests.

For example, the maximum yield of timber from a predominantly mature or overmature forest would be obtained by immediate harvest and regeneration. Such a procedure would not realize the benefits of uniform yield, stabilized industry, markets, and community support which are the goals of the second objective. Nor would such an accelerated harvest attain a balanced distribution of forest growing stock needed to provide for a uniform yield of timber at capacity in the future.

Likewise, cutting to provide a uniform yield of timber from a mostly mature or older forest cannot realize the maximum total yield possible. Such cutting would achieve the second objective and accelerate progress toward the third, but at some sacrifice in total timber yields.

The relative priority assigned to each of the three above objectives of sustained yield management must be a managerial decision. In management of the western national forests emphasis is placed upon achieving a reasonably uniform yield of timber. This fosters stabilization of industry, dependent communities and timber supply, and, in addition, stimulates progress toward a fully-regulated forest which can produce uniform yields at full capacity in the future.

In working circles having a very high preponderance of old-growth timber moderate adjustments may be made in the uniformity of timber yields and progress toward balanced growing stock if the total yield of needed timber products can be significantly increased thereby.

Thus, allowable cut for a given forest varies with objective of management as well as with such measures of timber volumes, growth, degree of utilization and effectiveness of forest management as are available. And it follows that changes in objectives or in measured timber volumes and growth or in the degree of utilization will result in changes in the allowable cut under sustained yield management.

## Timber Management Rotations

In the management of forests composed of even-aged stands for timber production, determination of the average length of time required to grow the major harvest of timber products to a desired size and average level of maturity is a critical consideration. This, together with the regeneration period necessary to establish a new stand, is the regulatory rotation which defines the average length of the "turnover" period, the time between major timber harvests. The rotation also defines the average rate of cutting by area over a working circle unit. For example, a rotation of 100 years implies that the total forest area will be cut over in 100 years. This makes decision as to the average rotation particularly important in the management of forests including large areas and volumes of old-growth timber as do the 42 western national forests. This is where interest in the rotation currently centers. The shorter the rotation, the faster old-growth stands will be cutover and the greater the consequent current cut, although this cut is not directly proportional to a change in rotation length because the impact on the growth of all stands in a working circle must also be taken into account.

There is no single or infallible method of determining the average rotation for a working circle; fundamentally, it is an integrative managerial decision with a number of considerations to be taken into account and balanced.

Common practice on the western national forests is to set the cutting age rotation at the culmination of mean annual increment (volume attained at a given age divided by the age) measured in terms of the

merchantability units primarily harvested, board feet in this situation. This is the age at which the board foot production of a natural stand maximizes. The length of the period so indicated naturally varies by species and quality of the land for timber growing--the site.

The basis for cutting age rotation determination on the national forests is primarily a body of forest information given in what are known as normal yield tables that have been prepared for principal western forest types. These tables show volumes of natural, uncut and fully-stocked stands that are attained on given sites and for given ages. This body of data is the best single source available, but its use is tempered by consideration of empirical yield information, where available, gained from stands under management.

The length of the regeneration period elapsing between the final harvest of a stand and establishment of adequate forest reproduction of desirable species for the next crop must be added to the cutting age rotation. It cannot be assumed that new reproduction immediately replaces the stand harvested; there is some time lost under the best of conditions. This regeneration period is a part of the regulatory rotation. For example, if the cutting age rotation is 90 years and the regeneration period is 10 years, the forest must be organized on a 100-year regulatory rotation to provide that the desired cutting age of 90 years is achieved.

The length of this regeneration period can only be determined by the facts of experience on the ground. At present, the Forest Service uses between 5 and 10 years and believes that 10 years is optimistic in some situations. As better regenerative methods are employed, the period will be shortened accordingly. Systematic and objective methods of periodic evaluation are necessary and more effort is needed in this direction. The length of the regeneration period is a matter of cold fact on the ground, not of opinion and is variable area by area. It cannot be ignored nor should it be a basis for general built-in optimism or conservatism.

Use of the above basis for determining the length of the regulatory rotation indicates western rotations ranging from 80 to 160 years. It does not seem helpful here to detail past rotation history on these 42 forests. The specific length depends on the forest type, average site, and the utilization assumptions made plus the regeneration period. For example, a cutting age rotation based on Scribner Decimal C log rule and utilization of trees 11 inches in diameter breast high and larger is longer than a rotation based on International 1/4-inch rule including all trees 7 d.b.h. inches and larger. The latter assumes more complete utilization which accounts for most of the difference. The rotation would be still shorter were it based on cubic foot utilization down to 4 inches.

During the past decade tremendous changes have occurred in the development of timber management on the western national forests, in the importance of this resource to the economy, and in the more complete utilization of timber harvest as previously discussed. Rotations have been substantially shortened accordingly. A change in

policy adopted in 1961 basing the cutting age rotation on culmination of growth in terms of International 1/4-inch rule including trees 7 inches and larger to a 6-inch top is noteworthy. This shortens existing average rotations, commonly based on Scribner rule (and excluding trees smaller than 11 inches d.b.h.), generally from 10 to 25 years. This change envisages economic utilization of smaller trees in the future. It accounts for much of the increases in allowable cuts now being calculated on the basis of latest inventory information available.

An important consideration in rotation determination stems from the nature of yield tables currently used as the primary basis for cutting age rotation calculation. They envisage fully-stocked natural stands that are cut only once--at rotation age. They do not measure the total growth made in a stand during its life, much of which might be captured by intermediate cuttings to forestall and recover mortality that naturally occurs, and to improve the quality growth of the stand. To the extent such intermediate cuts can be made and financial considerations of costs and returns are injected, rotation length is changed. It may be either longer or shorter than that determined by culmination of mean annual increment of the main stand only, depending on the particular cutting and value assumptions employed.

The degree to which intermediate harvests can profitably be employed in the future and whether, if so, the western forest industry may come to be primarily on a fiber rather than a saw log basis, are matters of long-range projection and an arena into which the Board does not enter. It is aware of the present utilization situation and of trends, particularly as indicated on the more intensively managed private properties.

Under fairly intensive management of well stocked and growing stands, rotation length may not be a particularly critical consideration. As long as trees and stands are well within their range of physiological good vigor they can maintain high net volume and value growth rates per acre with comparatively low stand densities over rather long periods of time. Decision as to time of major harvest depends on how long what is considered a satisfactory rate of return can be maintained in view of current utilization. The situation is analogous to a factory. As long as it is efficiently productive, no one would tear it down just because it had been used some arbitrary number of years. The same is true in a forest stand. There is no point in liquidating it and undergoing the very considerable expense, loss in time, and some very real hazards and uncertainty in rebuilding it through regeneration, as long as it is producing efficiently.

It should also be recognized that average rotations as now applied are flexible as in practice local site quality, stand, and regeneration conditions are taken into account. The working circle rotation is a guiding average that is necessary for regulatory planning but not an inflexible rule in application.

A direct method of rotation determination is to decide what size and character of products are primarily desired. If, for example, they

are trees averaging about 18 inches in diameter, the rotation is the time necessary to grow them. This time is a compound of species, site, and most important, the management methods employed. By proper spacing, and application of partial cuttings to maintain growth rate of major crop trees, it is possible to produce them in much shorter time than indicated by American normal yield tables which are conservative in this respect as they are based on unmanaged natural stands. The length of a rotation based on desirable product size is consequently variable, being a function of timber management methods employed. This is an area in which growth and stand structure studies are needed.

As indicated, there is no single or infallible method of determining a rotation. In dealing with the realities of the present situation, an average rotation length, including a necessary regeneration period, has to be set to give a planning framework for orderly management providing for sustained production. As previously stated, its immediate significance in the case of most of the 42 western forests is as a means of controlling the rate of cutting in old-growth stands; the harvest impact from managed stands is still largely in the future. The method presently employed by the Forest Service (culmination of mean annual increment based on International 1/4-inch rule in trees 7 inches d.b.h. and larger to a 6-inch top) is defensible and seems a reasonable median between very short and unreasonably long rotations. As better data on growth under management accumulate and utilization trends further develop average regulatory rotations should be changed accordingly. They may be shorter or perhaps longer in some situations. Regardless of what the future may bring, the Board feels rotations must be and are set on reasonably foreseeable realities. Continued analysis and appraisal is necessary.

## Calculation of the Allowable Annual Cut

All the facets of timber management come to focus on determination of the amount and kind of timber that can be harvested from a forest property during a particular period of time. The definition, components, and objectives of allowable cut determination, and its importance on the 42 western national forests to the western economy have been discussed. The purpose here is to examine basic methodology employed.

At the outset, it is essential to recognize that an allowable cut on the national forests--and elsewhere--is determined for a particular property for a set period of time, and is based on inventory and other forest information available at the beginning of the period plus forecasts of the future. In this sense, all allowable cuts are provisional. They can and should change as does the situation and information available.

For these reasons allowable cuts cannot be backdated to apply before their planned harvest period or safely projected beyond it. Regarding backdating, suppose it were true that a given forest unit had substantially the same timber volume 40 years ago as now and could have yielded about the same cut as estimated now. It cannot be supported

that this 40 years of possible cutting has accumulated, could be harvested in a lump now, and still proceed with the same annual cut under sustained yield principles. Similarly, projection ahead of the planned period is uncertain as conditions change. There can be major fires, insect epidemics, and shifts in utilization. The basic point is that all these factors are periodically reassessed at the beginning of each plan period, normally 10 years on the national forests, and an allowable cut determined accordingly. Interim adjustments are also made as changed conditions and information warrant.

The basic foundation for determination of the allowable annual cut is forest inventory data (including predictions of growth and yield), applicable knowledge on how to regenerate and grow stands, and prognostications regarding accessibility, and utilization. This body of information is applied to a specific area of forest land available for commercial forest production including areas in which timber use is modified to meet multiple-use objectives.

A considerable act of faith is embodied in allowable cut determination on the national forests. In timber management planning, it is assumed that needed additional roads will be built, that stands will be satisfactorily regenerated within the regeneration period allowed, that adequate protection will be given and productive silviculture applied, that utilization envisaged can be commercially achieved, that timber volumes estimated as available for cutting from complete sampling inventory data can, in fact, be made a reality in terms of operable timber sales, and finally, that sales can be financed and programed to meet the Forest Service objective of making the allowable cut actually available. These things cost money and require continued financial support to achieve.

Over the years, a considerable body of techniques has been developed for calculating an allowable cut which are expressed in various formulas and procedures employing area, volume, and combined approaches. Basically, area and volume approaches are not separate but complementary, as volumes are cut on areas and both must be considered in scheduling a cut on the ground. The Board is aware of these various approaches but will not review them here. Rather, the aim is to cut through them to consideration of basic principles and procedures applied on the 42 western national forests.

There are two general kinds of forests to consider and regulatory approaches differ accordingly. First, are forests that are primarily composed of even-aged stands and second, those that are composed of irregular stands of a generally mixed-age character. It should be made clear that, with the latter, it is not necessarily assumed that uneven-aged management will be permanently continued, but only that such stands cannot be classified by age because of their present structure and, at least currently, are handled on an uneven-aged regulatory basis. Each group will be reviewed separately.

Calculation for Forests Composed Primarily of Even-aged Stands

These forests are characteristically Douglas-fir, Sitka spruce-hemlock, western white pine, and the mixed conifer species associations. They are commonly called the west side forests in Washington, Oregon, and California, but forests of the same general character also occur in parts of Montana and Idaho. Nearly all of the working circles in this group (there are a few exceptions, notably the Siuslaw) characteristically include large areas and volumes of old-growth timber.

Various formulas and procedures are used. The most common is termed the Hanzlik approach which consists of two parts, a formula to give an indicated or trial cut, and an accompanying area-volume check which is the real control. The formula is:

$$\text{Allowable annual cut} = \text{Annual growth} + \frac{\text{Volume of mature timber}}{\text{Rotation}}$$

It was designed for West Coast areas including substantial areas supporting old-growth stands. It is not suitable for use in forests of predominantly young stands in which growth and availability of harvest-size material is the primary consideration, or for entirely old-growth forests for which the formula reduces to essentially straight area control.

In application of the formula, the volume of mature timber is usually considered as being that shown in the inventory as older than the rotation adopted. Annual growth is estimated in a number of ways; from periodic annual increment as determined by the inventory, from adjusted normal yield tables, or from empirical yields tables derived from the inventory. In any event, the indicated cut is regarded as a trial figure only. It can be, and is, determined from the Austrian or other formulas, or from just an educated guess. Use of a formula is not a critical matter.

The final allowable annual cut is determined by what is termed the area-volume check or the tabular method. In making this check, growth of the various component stands in the forest unit is estimated and specific techniques vary. Adjusted normal yield tables are often used. The adjustment may be a flat percentage of yields indicated by normal yield tables, or yield tables adjusted for stocking and approach toward normality by the Girard-Briegleb growth factors. A more direct approach is to derive an empirical yield table directly from the inventory data pertinent to the particular working circle under consideration. Essentially, this means that an average trend line is determined, usually mathematically, from the age-volume relationship given by the inventory data. From this established trend, the growth of any stand, say 30 years old at present, to rotation age, for example 90 years, is estimated on the basis of what stands in the working circle of similar site and stocking actually have produced. The process is conservative in that possible increased yields in the future from stands under management are not estimated. The estimate is based on present realities.

The essential feature of the check method is to determine an even annual volume of cut that can be sustained for the rotation period. Basically, it is the solution of a problem containing several conditions and variables. These are:

1. That the total commercial forest area is to be cut over during an established rotation planning period.

2. That stands are to be cut in approximately the order of their age starting with the overmature timber, or, in the case of irregular stands, in the order of whatever condition classes may be established starting with those having highest priority for cutting.

3. That an approximately even flow of annual harvest volume is to be maintained.

4. That there is a certain existing distribution of age classes by area (which may also be classified by site and stocking) or forest condition classes, and that these stands will grow at certain estimated rates (not necessarily constant or linear).

5. That timber of less than rotation age, or of some specified age less than rotation age and for some specified time duration, will not be cut during the rotation period. This fifth condition may or may not be formally imposed; in practice, it usually works out that little timber under rotation age is cut anyway.

Given these conditions, there is some volume of annual cut that will satisfy them.[1/] This volume is determined by a cut-and-try process starting with a trial annual cut figure and repeating the process until one is found that can be sustained over the rotation period and forest area. This means that a constant annual cut is projected through the area of age or condition classes in order of cutting priority. The time required to cut each as they are reached is determined and also their volume at the time of cutting. The sum of these cutting periods necessarily equals the rotation. The cut is normally adjusted so that the sum of cutting periods comes out to not more than plus or minus two years of the established rotation.

This is volume regulation and it should be recognized that a weakness of any volume approach is that the annual cut figure so determined is entirely controlled by volume inventory and growth estimates. If these estimates are in error (and their basis in the present stage of management information is rather crude), or if volume estimates cannot be translated into timber cut in operable sales, there is no assurance that the working circle area will, in fact, be covered and planned timber management measures will be applied to the forest area.

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1/ Theoretically, there could be more than one solution, especially if the yield table projection curves are not ascending but dip down with older age classes. In practice, the possibility of multiple solutions is not important.

The approach does not include any specific objective to improve future age class distribution; variable areas are necessarily cut over and regenerated during the rotation period to maintain an even flow of harvest from an unregulated forest. Improvement in age class-area distribution does occur as a by-product of the check procedure and results from the fact that the working circle is planned to be cut over systematically. In practice, the improvement is probably adequate, all things considered, and it must be recognized that the management situation is reassessed at about 10-year intervals. The Board believes, however, that some direct attention to achievement of future age class regularity through modified area control could be injected into the allowable cut determination process without undue violation of the need for reasonably even harvest flow.

The basic point is that there is no painless way to make progress toward regulating an unregulated forest. Reasonable progress toward better age class distribution, certainly one important aim in timber management for sustained yield as previously pointed out, is in partial conflict with attainment of an entirely even flow of harvest. Some reasonable compromise is needed.

The area-volume check approach should be recognized as a variation of the ancient and time-honored area and volume allotment procedure applied to western forest conditions. It is a flexible approach. Limiting conditions established can be varied to suit the circumstances and the procedure provides a framework for the working out of an allowable cut in line with realities and needs--which is the essence of good forest management on the ground.

In summary, the Board believes that the methods now being applied to determine allowable annual cuts in forests composed of even-aged stands give reasonable and defensible results. It does not feel that any single approach should be prescribed; forests and conditions are too variable. Continued scrutiny of methodology is important to insure that the best available procedure and data are employed. The real questions about allowable cuts do not lie in improved mathematical procedures as such, but in the need for (1) better knowledge of the forest and its growth, (2) policy regarding the speed of transition from dominantly old-growth to younger, managed forests, and (3) present or projected utilization upon all of which methodology is based.

Calculation for Irregular Stands

Allowable cut for the extensive ponderosa pine, mixed conifer and other irregular forests on the western national forests is calculated by a variety of formulas supplemented by area-volume allotment checks as previously described. The Austrian formula is most frequently used for computation of a preliminary estimate of cut:

$$\text{Allowable annual cut} = \text{Average annual growth in conversion period} + \frac{\text{Measured volume - Desirable volume}}{\text{Years in conversion period}}$$

Measured volume is obtained by inventory. Desirable volume is estimated by summation and discount of normal yield table values.

The conversion period is the estimated number of years required to bring net growth up to the estimated potential level for the desired volume of growing stock and anticipated intensity of management.

Its length is based on such items as relative area of virgin, residual and second-growth stands; proportion of total road system completed; comparison of net growth in virgin, residual and second-growth stands with the estimated potential growth rate for the types and sites under consideration. The conversion period is ordinarily somewhat less than a rotation.

The proportion of virgin old-growth in a working circle has a strong influence in deciding on the period to use. For example, for a working circle having 80 percent old-growth and 20 percent second-growth by area and with a 125-year rotation, a conversion period of about 100 years might be selected. Obviously, 80 percent of 125 years equals 100 years. However, if the old-growth is fairly accessible or can be readily made so, and if it has a thrifty, well-developed immature understory it may be possible to complete the conversion in a shorter period, say perhaps 80 years.

If, however, such an understory is largely lacking, and regeneration and access are known to be extremely difficult, a longer conversion period--perhaps 110 years--might be necessary.

Current growth and mortality is variously estimated by systematic plot samplings, results of research studies, or yield tables--from whatever source is judged best.

Preliminary estimates of allowable cut are supplemented by stand condition class analyses and a recommended cut selected subjectively. This approach focuses attention on growth and growing stock objectives, and if properly controlled with systematic growth and mortality data it should result in progress toward the goals selected, or in timely revision of goals to more realistic levels.

In using the Austrian approach, it is important to remember that only one of the four independent variables in the formula is based on direct measurement, i.e., present volume. All the estimates of future growth and mortality, of desirable volume, and of the number of years required to attain growth and growing stock goals are based on more or less subjective assumptions.

Sustained yield management and computations of allowable cut thereunder --some to be made far in the future--require assumptions about the future. The important thing to remember is that estimates of future growth and growing stock must be checked objectively and continuously so that errors may be corrected promptly and abrupt impacts on cuts avoided.

The particularly wide variations in precipitation with resulting wider swings in tree growth and mortality in the ponderosa pine region could

lead to gross errors in estimates of future increment in this area, necessitating drastic changes in the volume of timber cuts possible in the future. In some working circles more than 75 percent of the anticipated future cut is expected to come from wood predicted to be grown between now and the time of harvest. Such predictions need to be checked as soon as possible and in succeeding decades thereafter.

Since about 1940, precipitation and tree growth rates in the pine areas have been generally above the long-time average. Thus, there is a probability that succeeding decades may bring something less than average precipitation and less than average tree growth. If so, future cuts will need to be reduced below what would have otherwise been possible.

Application of sanitation-salvage, regeneration, improvement and other conditioning cuts are well underway in the western pine region national forests. Thus, it is high time to supplement the Austrian approach to regulation with a systematic analysis of trends in diameter distribution and spacing under management. Results of such study will soon be urgently needed to identify possible deficiencies in growing stock structure, to prescribe management measures to relieve them, and further to increase growth. This should be a logical early cooperative project for National Forest Administration and Research.

Many of the future growth and mortality predictions in management plans for the western national forests are based on assumptions of increasingly intensive management practices not yet realized. Stand improvement, recovery of mortality and similar measures to increase growth must be intensified and accelerated if predicted yields are to be achieved. This is an added reason why objective measures of growth actually obtained are urgently needed. If management practices actually applied are found to be more effective than anticipated, the allowable cut should be appropriately increased; if less effective, management will have to be further intensified or the cut reduced accordingly.

## Cut for Modified Timber Use Under Multiple-Use Management

Recent and increasing application of multiple-use forest land management presents new and important considerations in the determination of the allowable cut on the 42 western national forests. At present, approximately 6 percent of the total commercial forest land area, exclusive of formally established wilderness, wild areas, etc., is estimated as under varying degrees of timber harvest restriction. The proportion of area affected is naturally highly variable in particular situations and the total area is expected to increase. These restrictions are applied to roadside strips, scenic or landscape areas near roads or recreation areas, and related designations made in multiple-use area plans.

At present, policies and practices on the ground are in the process of being defined and clarified; this is a new and developing situation. Complete restriction of cutting is seldom desirable; all areas need to receive management to preserve the values for which they are

designated. The basic questions are what kind of management and specifically what cutting practices should be applied. It is also recognized that modifications in timber use that necessitate application of methods different from those practiced on unrestricted timber use areas inevitably will increase timber management costs. Governing policies and practices should be established as soon as possible on a reasonable and realistic basis.

Current practices on the western forests are as follows:

> Region 5. Annual cut is set at the equivalent of net current periodic increment. Since the stands involved are predominately overmature, this is but a fraction (sometimes less than a fifth) of the mean annual increment. Obviously, it is not practically possible to prevent decadence at this rate of treatment. Unsalvaged mortality losses and a long-time trend to less pleasing landscapes may be expected.
>
> Region 6. Annual cut is set at the equivalent of gross periodic increment. The reasoning which supports this basis is that such cutting will approximately maintain the existing level of growing stock but gradually substitute younger and healthier stands for those now existing.
>
> Region 1. Annual cut is set at the same rate developed for the general commercial forest area. This assumes that modifications of methods of cutting and logging, and of sale timing, layout, and cleanup will suffice without affecting the rate of regeneration cutting. The assumption appears sound for Region 1 conditions and in time may be for conditions elsewhere.

To minimize the likelihood of parts of these areas being withdrawn entirely from commercial timber production, it is considered desirable in Regions 5 and 6 to convert old-growth timber in modified timber use areas at a rate somewhat slower than that adopted for areas where landscapes are less important. To provide for this, additions to rotations (up to a maximum total of 160 years) were suggested in the Forest Service Handbook instructions of February 27, 1962. This approach has not yet been tried.

It is difficult to establish any rotation as such for the management of modified timber use areas. Conditions are variable and, in the main, some form of partial cutting is appropriate at least for the present. Ultimately, regeneration will be necessary and this may require heavier cuttings in some areas than would be applied under a selection system. In any event, cuttings should be applied in such a way--selectively, in small patches, strips, or shelterwoods--as to be consonant with the land use purposes of the areas designated.

The Board believes that basing allowable cut estimates on growth is a sound approach that gives sufficient flexibility to meet local needs. Gross periodic increment will, as pointed out, result in maintenance of healthy and durable stands and appears a desirable basis. Net periodic increment will permit very little cutting in old-growth stands, which average little net growth, and appears very conservative as an average base. It should be applied only where specific conditions require.

The Board believes strongly that policy and practice regarding cutting on modified timber use areas should be faced squarely. At present, there seems to be a tendency for forest resource managers on the ground to avoid cutting in such areas because of uncertainty as to policy and procedure.

## CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are not made in any order of priority. In general, they follow the sequence of supporting development in the body of the report.

### 1. Size of Working Circles

The Board believes that the enlargement of working circles has contributed constructively to a more rapid development of national forests and their contribution to the western forest economy. It believes that the Forest Service should carry out its plans to further combine smaller working circles into larger planning units. The Board recommends continuing study of opportunities for additional improvements in the geographic areas for which allowable cuts are calculated, and it recognizes that improvements may not always involve increases in working circle size as management becomes more intensive.

### 2. Road Financing

The present method and level of national forest road financing leads to some advance roading but fails to make adequate provision for a rate and direction of road development which will provide for maximum utilization of the national forest timber resource and its growth. It tends to preclude proper management of young growth. It leads to inefficient utilization of accumulated salvage and mortality losses, and delays conversion of the least productive timber stands to more productive second growth. In allocating the allowable cut to species, grades and locations, it sometimes leads to conflicts between the road objectives of the Forest Service for developing the national forests and the demands of forest industries for an optimum economic log supply.

The Board recommends that both the level and flexibility of road financing be substantially increased so that the roading program can be geared to the optimum development of the total timber resource rather than being undesirably limited to harvesting the allowable cut where the timber harvested is able to bear the cost of road construction.

### 3. Study of National Forest Contributions to the Western Timber Economy

The Board recommends that the Forest Service continue objective and quantitative studies of the economic role of national forest timber management in terms of several alternative input levels and several alternative harvest plans and schedules and to evaluate the advantages and disadvantages of such alternatives to the national and regional economies.

4. Future Utilization

The Board recommends that the goals of national forest timber management include definition of desired tree diameters and grades for the final harvest cuts which will be made after the conversion of over-rotation age timber. Substantial study will be required.

5. Intensification of Forest Inventories

The intensity and quality of effort channeled into modern inventories for the 42 national forests under consideration have been greatly increased in the past six years. This effort will need to be continued and intensified in the five-year period ahead, with special emphasis on obtaining growth information from the semi-permanent samples established during the initial inventory, and on obtaining supplementary area-by-area information on operability, accessibility, and local silvicultural conditions.

6. Growth Prediction

New techniques of predicting growth for both managed and unmanaged stands should modify, supplement, or replace existing methods as soon as actual analysis of semi-permanent growth and mortality samples indicate superiority with respect to reliability or applicability. Prediction of growth and mortality on individual samples by several methods in advance of remeasurement will provide the only objective evaluation of current or proposed techniques. Feed-back after remeasurement will improve initial estimates of growth parameters wherever growth has been expressed as a function of structure.

7. Sample Tree Measurement

The four national forest regions involved should make renewed efforts (including consultation with other agencies, public and private, other Forest Service regions, and research personnel) to test or adapt a sample tree measurement procedure (employing optical dendrometers and electronic computers) that will serve both as a more satisfactory basis for control (i.e., depletion) in management planning, and as a more efficient basis for sale than log scaling.

8. Units of Measure

The Forest Service should undertake on an orderly nationwide basis, such steps as it deems necessary to change its primary units of measurement in inventory and sales from board feet or cubic feet alone to cubic feet of volume, square feet of circumferential surface,

and lineal feet of length. These three objective and relatively invariant measurements apply to both standing or felled timber, are individually additive or accumulative, and contain the basic information as to volume, size, and rate of taper needed in appraisals and for conversion into a wide variety of product yields with any specified utilization or processing standards.

9. Inventories Designed for Timber Management Planning

Progress in coordinating national forest timber management planning inventories with Forest Surveys has been good, and on the whole, beneficial. Where present Forest Survey procedures are not well adapted to the needs of management planning, renewed efforts should be made to revise or else supplement them to incorporate the desired features. Timber management planning should never be shackled (for the sake of uniformity) to designs or procedures not well adapted to achieve its objectives.

10. Utilization of Thinnings and Other Timber Not Now Included in the Regulated Annual Cut

The Board recommends that the Forest Service continue and strengthen its efforts to develop accessibility, uses, and operating methods that will increase the value of the potential timber harvest of thinnings and other timber not now included in the regulated annual cut as an economic industrial raw material. Such utilization represents an opportunity to increase future allowable cuts, more nearly capture the growth potential of the forest, and to reduce misunderstandings about allowable cut figures and the supplementary cuts possible where conditions permit on the national forests.

11. Regeneration Period

An allowance for the time necessary to establish reproduction following final harvest cutting must be included in the regulatory rotation to provide that timber of the average desired cutting age is produced. The length of this regeneration period can only be determined by experience on the ground and local conditions vary greatly. Systematic and objective methods should be applied to measure the establishment of reproduction following cutting. This information, with appropriate standards for what is adjudged to constitute acceptable regeneration, should be used to revise the regeneration period as the results warrant.

12. Modified Timber Use

A timber harvest should be taken from modified timber use areas (designated for scenic, landscape, or related

purposes) to maintain the forest values for which they were designated and to prevent wastage of a utilizable resource. Governing policies and procedures should be established and applied as soon as possible to effect coordination between multiple-use objectives and reasonable timber harvest. In determination of planned yield from these areas as a part of the regulated allowable annual cut, the Board suggests a cutting control set at either (1) the same rate used for the principal cut, or (2) the equivalent of gross periodic increment. Choice of control and methods of cutting applied should depend on needs in local situations. Continued test and study of cutting prescriptions should be made.

13. Forest Service-Customer Communication

In its contacts with industry people the Board encountered comments and criticism regarding communication with the Forest Service regarding timber matters. There was feeling that operators, association representatives, etc., were not given timely and adequate information, particularly on the initiative of the Forest Service, about road construction plans, allowable cuts and changes being made, availability of management plans, changes in policy and practices of timber cutting, etc., that deeply affect them. The Board cannot assess this matter quantitatively or in detail but considers it important--and also recognizes that there are two sides to such matters. The Board commends work that has been and is being done to give concerned people timely timber business information and believes that this work should be emphasized and strengthened.

14. Personnel Experience and Stability

The Board received a number of comments from several quarters to the effect that a substantial part of Forest Service-user difficulties that have developed are a welling-up of instances of one sort or another. In large degree they stem from lack of experienced men on the job, disruptive personnel transfers from a timber user standpoint, pulling off men for other national forest work, and related reasons. This is not a new problem and is well recognized within the Service. The necessity of meeting forest exigencies and the nature of multiple-use management is also appreciated. The Board would stress, however, the importance of maintaining strong and attractive career ladders in a major functional use, as is timber, to minimize user difficulties.

A deeper reason, as regards timber use, is that knowledge and experience concerning the establishment, protection, and manipulation of forest cover centers

in the timber management group. This knowledge is requisite to the effectuation of most forest land uses.

15. Objective and Well-understood Standards and Procedures for Allowable Annual Cut Determination

In the body of the report and in the recommendations a number of references to objectives and standards have been made that the Board wishes to pull together in a general statement. In such things as inventory work, growth measurement, regeneration period, and determination of the cut as presented in timber management plans, every effort should be made to lay things clearly and objectively on the line so that they will be understood by the timber user. If standards and procedures are well understood and on a measurement basis, then changes as indicated by the data should also be better accepted as plans are periodically revised.

16. Attainment of Current Allowable Cut Objectives

The Board has been fully advised and has had opportunity to consult with the Forest Service regarding current action being taken to increase allowable annual cuts to be reported to the Secretary of Agriculture by October 15. As stated on page 26 and elsewhere in this report, the goal of making projected annual cuts a reality in terms of operable timber sales represents a considerable act of faith in what the future will bring. Allowable cuts calculated now envisage a substantial increase in future intensity of timber management. To achieve this intensity, strong and continued financial support of the National Forest Program is necessary.

SUMMARY TABLE I

CURRENT TIMBER MANAGEMENT STATISTICS

FOR FORTY-TWO WESTERN NATIONAL FORESTS

| REGION | STATE | NATIONAL FOREST | Number of Working Circles | COMMERCIAL FOREST LAND 1/ | | | CURRENT INVENTORY | | | CURRENT ANNUAL ALLOWABLE CUT | | | Unregulated Objective | Allowable Annual Cut as of 1/1/61 | Actual Cut F.Y. 1962 | Timber Use Receipts F.Y. 1962 | Total Receipts F. Y. 1962 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Unmodified Timber Use | Modified Timber Use | Total | Unmodified Timber Use | Modified Timber Use | Total | Unmodified Timber Uee | Modified Timber Use | Total | | | | | |
| | | | | M acres | M acres | M acres | MM BD. FT. | MM BD. FT. | MM BD. FT. | MM BD. FT. | MM BD. FT. | MM BD. FT. | MM CU. FT. | MM BD.FT. | MM BD. FT. | M. dollars | M. dollars |
| 1 | Mont. | Flathead | 4 | 1,192 | - | 1,192 | 8,592 | - | 8,592 | 127 | - | 127.0 | 13 | 116 | 126.7 | 973.4 | 983.9 |
| | | Kootenai | 1 | 1,703 | - | 1,703 | 10,979 | - | 10,979 | 164 | - | 164.0 | 30 | 164 | 170.9 | 1,034.6 | 1,041.0 |
| | | Lolo | 3 | 1,968 | - | 1,968 | 12,378 | - | 12,378 | 178 | - | 178.0 | 23 | 157 | 126.5 | 698.7 | 710.6 |
| | Ida. | Clearwater | 3 | 1,180 | - | 1,180 | 11,372 | - | 11,372 | 171 | - | 171.0 | 14 | 158 | 131.5 | 740.9 | 745.1 |
| | | Coeur d'Alene | 1 | 689 | - | 689 | 5,951 | - | 5,951 | 100 | - | 100.0 | 11 | 127 | 110.4 | 811.5 | 814.0 |
| | | Kaniksu | 3 | 1,442 | - | 1,442 | 6,565 | - | 6,565 | 132 | - | 132.0 | 14 | 132 | 143.5 | 747.1 | 763.0 |
| | | Nezperce | 1 | 1,230 | - | 1,230 | 7,974 | - | 7.974 | 98 | - | 98.0 | 18 | 98 | 72.9 | 205.3 | 231.8 |
| | | St. Joe | 1 | 815 | - | 815 | 5,452 | - | 5,452 | 93 | - | 93.0 | 7 | 52 | 46.4 | 227.6 | 232.3 |
| | Wash. | Colville | 1 | 827 | - | 827 | 4,421 | - | 4,421 | 68 | - | 68.0 | 12 | 68 | 61.4 | 594.8 | 612.6 |
| TOTAL | | | 18 | 11,046 | - | 11,046 | 73,684 | - | 73,684 | 1,131 | - | 1,131.0 | 142 | 1,072 | 990.2 | 6,033.9 | 6,134.3 |
| 4 | Idaho | Boise | 1 | 1,353 | - | 1,353 | 11,779 | | 11,779 | 129.9 | | 129.9 | 2.9 | 130 | 141.4 | 970.3 | 1,013.7 |
| | | Payette | 1 | 670 | - | 670 | 9,155 | | 9,155 | 91.5 | | 91.5 | 3.0 | 91 | 69.5 | 308.7 | 347.3 |
| TOTAL | | | 2 | 2,023 | - | 2,023 | 20.934 | | 20,934 | 221.4 | | 221.4 | 5.9 | 221 | 210.9 | 1,279.0 | 1,361.0 |
| 5 | Calif. | Eldorado | 4 | 335.7 | 46.0 | 381.7 | 8,251.4 | 1,104.9 | 9,356.3 | 115.9 | - | 115.9 | | 96 | 68.4 | 731.1 | 887.5 |
| | | Klamath | 6 | 970.3 | 48.4 | 1,018.7 | 19,219.8 | 1,131.7 | 20,351.5 | 218.7 | 3.3 | 222.0 | 0.2 | 183 | 170.3 | 1,136.8 | 1,153.1 |
| | | Lassen | 5 | 727.9 | 23.0 | 750.9 | 10,449.6 | 378.6 | 10,828.2 | 147.6 | - | 147.6 | 1.5 | 95 | 94.3 | 1,239.4 | 1,293.9 |
| | | Mendocino | 5 | 308.8 | 7.9 | 316.7 | 7,213.0 | 187.9 | 7,400.9 | 81.0 | 0.4 | 81.4 | | 76 | 90.9 | 624.1 | 634.7 |
| | | Modoc | 4 | 570.5 | 2.0 | 572.5 | 4,704.1 | 17.0 | 4,721.1 | 50.6 | (2.2) | 50.6 | 2.2 | 51 | 35.6 | 354.3 | 419.6 |
| | | Plumas | 4 | 811.5 | 61.9 | 873.4 | 12,980.9 | 1,219.8 | 14,200.7 | 186.4 | 6.1 | 192.5 | | 169 | 141.0 | 1,298.1 | 1,325.6 |
| | | Sequoia | 4 | 368.6 | 46.8 | 415.4 | 8,442.4 | 848.9 | 9,291.3 | 101.2 | - | 101.2 | | 86 | 34.3 | 81.0 | 136.5 |
| | | Shasta-Trinity | 8 | 1,416.1 | 85.5 | 1,501.6 | 20,501.1 | 1,035.0 | 21,586.1 | 256.4 | 3.2 | 259.6 | 1.5 | 218 | 172.3 | 2,939.1 | 2,981.7 |
| | | Sierra | 5 | 357.7 | 33.6 | 391.3 | 10,936.7 | 1,183.1 | 12,119.8 | 144.1 | - | 144.1 | 9.1 | 91 | 122.8 | 488.4 | 550.3 |
| | | Six Rivers | 3 | 615.4 | 6.2 | 621.6 | 15,363.0 | 163.7 | 15,526.7 | 160.4 | - | 160.4 | | 162 | 88.9 | 925.4 | 939.0 |
| | | Stanislaus | 4 | 360.8 | 28.9 | 389.7 | 8,267.6 | 795.5 | 9,063.1 | 123.2 | - | 123.2 | | 102 | 91.0 | 294.9 | 385.5 |
| | | Tahoe | 4 | 470.4 | 47.6 | 518.0 | 9,528.6 | 994.1 | 10,522.7 | 136.2 | 2.1 | 138.3 | 1.3 | 109 | 134.9 | 674.6 | 714.9 |
| TOTAL | | | 56 | 7,313.7 | 437.8 | 7,751.5 | 135,858.2 | 9,110.2 | 144,968.4 | 1,721.7 | 15.1 | 1,736.8 | 15.8 | 1,438 | 1,294.7 | 10,787.2 | 11,422.3 |
| 6 | Ore. | Deschutes | 1 | 1,278 | 81 | 1,359 | 11,417 | 1,065 | 12,482 | 136 | | 136 | | 136 | 164.7 | 2,094 | 2,131 |
| | | Fremont | 1½ | 903 | 12 | 915 | 8,309 | 192 | 9,001 | 126 | | 126 | | 126 | 100.4 | 1,430 | 1,458 |
| | | Malheur | 1½ | 1,238 | - | 1,238 | 11,434 | - | 11,434 | 171 | | 171 | | 138 | 134.9 | 822 | 866 |
| | | Mt. Hood | 2 | 734 | 305 | 1,039 | 20,405 | 9,224 | 29,629 | 315 | | 315 | | 315 | 336.7 | 6,966 | 6.997 |
| | | Ochoco | 1½ | 680 | 10 | 690 | 8,856 | 96 | 8,952 | 98 | | 98 | | 96 | 119.7 | 1,172 | 1,191 |
| | | Rogue River | 1 | 511 | 48 | 559 | 13,049 | 687 | 13,736 | 158 | | 158 | | 135 | 189.0 | 2,664 | 2,676 |
| | | Siekiyou | 1 | 694 | 215 | 909 | 16,170 | 1,590 | 17,760 | 184 | | 184 | | 185 | 230.3 | 2,886 | 2,887 |
| | | Siuslaw | 3 | 500 | 78 | 578 | 27,408 | 3,402 | 30,810 | 327 | | 327 | | 315 | 379.5 | 8,939 | 8,944 |
| | | Umatilla | 2 | 861 | 182 | 1,043 | 8,683 | 2,055 | 10,738 | 129 | | 129 | | 110 | 89.1 | 446 | 468 |
| | | Umpqua | 1 | 933 | 26 | 959 | 31,281 | 809 | 32,090 | 340 | | 340 | | 303 | 315.2 | 5,840 | 5,854 |
| | | Wallowa-Whitman | 2 | 1,403 | 80 | 1,483 | 13,049 | 802 | 13,851 | 160 | | 160 | | 121 | 115.3 | 702 | 790 |
| | | Willamette | 2 | 1,206 | 128 | 1,334 | 59,181 | 7,027 | 66,208 | 566 | | 566 | | 529 | 715.8 | 13,161 | 13,172 |
| | | Winema | ½ | 727 | 91 | 818 | 7,714 | 744 | 8,458 | 90 | | 90 | | 90 | 75.5 | 1,277 | 1,317 |
| | Wash. | Gifford Pinchot | 1 | 884 | 38 | 922 | 35,768 | 708 | 36,476 | 395 | | 395 | | 395 | 415.2 | 6,963 | 6,969 |
| | | Mt. Baker | 2 | 692 | 42 | 734 | 26,325 | 1,341 | 27,666 | 201 | | 201 | | 201 | 244.2 | 2,556 | 2,560 |
| | | Okanogan | 1 | 874 | 370 | 1,244 | 6,988 | 368 | 7,356 | 90 | | 90 | | 70 | 66.5 | 443 | 469 |
| | | Olympic | 4 | 517 | 12 | 529 | 20,109 | 143 | 20,252 | 341 | | 341 | | 341 | 252.0 | 3,456 | 3,462 |
| | | Snoqualmie | 7 | 742 | 256 | 998 | 23,115 | 5,781 | 28,896 | 207 | | 207 | | 207 | 203.1 | 2,365 | 2,414 |
| | | Wenatchee | 4 | 760 | 201 | 961 | 12,591 | 976 | 13,567 | 107 | | 107 | | 107 | 106.1 | 728 | 740 |
| TOTAL | | | 39 | 16,137 | 2,175 | 18,312 | 362,352 | 37,010 | 399,362 | 4,141 | | 4,141 | | 3,920 | 4,253.3 | $64,910 2/ | $65,365 2/ |
| GRAND TOTALS | | | 115 | 36,520 | 2,613 | 39,133 | 592,828 | 46,120 | 638,948 | 7,215 | 15 | 7,230 | 164 | 6,651 | 6,749 | 83,010 | 84,283 |

1/ Excluding wilderness, occupancy and deferred areas
Data as of 1/31/62 available for future planning

2/ In addition to the totals shown, R-6 collected approximately $4,282 M timber receipts and $4,283 M total receipts from O & C and Warm Springs lands administered by the Forest Service. These areas are included in allowable cut calculations.

SUMMARY TABLE II

ALLOWABLE AND ACTUAL TIMBER CUT, 1952 - 1962

FOR FORTY-TWO WESTERN NATIONAL FORESTS

| REGION | STATE | NATIONAL FOREST | F. Y. 1952 | | F. Y. 1953 | | F. Y. 1954 | | F. Y. 1955 | | F. Y. 1956 | | F. Y. 1957 | | F. Y. 1958 | | F. Y. 1959 | | F. Y. 1960 | | F. Y. 1961 | | F. Y. 1962 | | CURRENT ANNUAL ALLOWABLE CUT AS OF 1/1/62 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Allow. Cut 1/ | Actual Cut | Allow. Cut 1/ | Actual Cut | Allow. Cut 1/ | Actual Cut | Allow. Cut 1/ | Actual Cut | Allow. Cut 1/ | Actual Cut | Allow. Cut 1/ | Actual Cut | Allow. Cut 1/ | Actual Cut | Allow. Cut 1/ | Actual Cut | Allow. Cut 1/ | Actual Cut | Allow. Cut 1/ | Actual Cut | Allow. Cut 1/ | Actual Cut | |
| | | | MMBF | | MMBF | | MMBF | | MMBF | | MMBF | | MMBF | | MMBF | | MMBF | | MMBF | | MMBF | | MMBF | | MMBF |
| 1 | Mont. | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Flathead | 58 | 39 | 58 | 66 | 60 | 73 | 60 | 103 | 60 | 94 | 60 | 80 | 84 | 93 | 84 | 88 | 91 | 99 | 106 | 109 | 116 | 126.7 | 137 |
| | | Kootenai | 84 | 71 | 84 | 112 | 84 | 116 | 118 | 217 | 118 | 228 | 118 | 235 | 135 | 137 | 135 | 163 | 135 | 172 | 164 | 138 | 164 | 170.9 | 185 |
| | | Lolo | 38 | 24 | 38 | 34 | 55 | 60 | 55 | 97 | 55 | 111 | 55 | 84 | 129 | 88 | 104 | 99 | 104 | 110 | 144 | 103 | 157 | 107.0 | 162 |
| | Ida. | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Clearwater | 88 | 18 | 88 | 31 | 88 | 42 | 82 | 46 | 82 | 70 | 82 | 66 | 110 | 76 | 110 | 103 | 110 | 138 | 158 | 109 | 158 | 131.5 | 211 |
| | | Coeur d'Alene | 75 | 66 | 75 | 71 | 75 | 60 | 75 | 67 | 83 | 73 | 83 | 78 | 90 | 93 | 111 | 91 | 121 | 115 | 121 | 125 | 127 | 129.8 | 151 |
| | | Kaniksu | 68 | 46 | 68 | 67 | 93 | 98 | 93 | 105 | 96 | 109 | 96 | 133 | 123 | 100 | 113 | 96 | 113 | 114 | 118 | 91 | 132 | 143.5 | 140 |
| | | Nezperce | 79 | 44 | 79 | 49 | 79 | 55 | 81 | 62 | 81 | 90 | 81 | 62 | 77 | 46 | 98 | 81 | 93 | 88 | 98 | 76 | 98 | 72.9 | 112 |
| | | St. Joe | 52 | 20 | 52 | 27 | 52 | 39 | 52 | 62 | 52 | 49 | 52 | 57 | 52 | 23 | 52 | 35 | 52 | 67 | 52 | 67 | 52 | 46.4 | 100 |
| | Wash. | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Colville | 18 | 27 | 18 | 30 | 30 | 30 | 37 | 48 | 43 | 34 | 43 | 41 | 65 | 54 | 65 | 58 | 68 | 62 | 68 | 49 | 68 | 61.4 | 80 |
| | TOTAL | | 560.0 | 355.0 | 560.0 | 437.0 | 616.0 | 573.0 | 653.0 | 807.0 | 670.0 | 863.0 | 670.0 | 836.0 | 865.0 | 710 | 872 | 814 | 892 | 965 | 1,029 | 867 | 1,072 | 990.1 | 1,278 |
| 4 | Ida. | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Boise | 34.1 | 38.1 | 34.1 | 29.4 | 38.0 | 49.5 | 38.0 | 102.1 | 38.0 | 118.1 | 129.9 | 111.7 | 129.9 | 78.0 | 130 | 112.9 | 130 | 129.2 | 130 | 125.4 | 130 | 141.5 | 130 |
| | | Payette | 24.0 | 20.5 | 24.0 | 30.4 | 66.0 | 37.1 | 66.0 | 50.0 | 66.0 | 54.0 | 66.0 | 76.7 | 81.0 | 81.3 | 81 | 71.0 | 81 | 83.0 | 91 | 55.4 | 91 | 70.0 | 91 |
| | TOTAL | | 58.1 | 58.6 | 58.1 | 59.8 | 104.0 | 86.6 | 104.0 | 152.1 | 104.0 | 172.1 | 195.9 | 188.4 | 210.9 | 159.3 | 211 | 183.9 | 211 | 212.2 | 221 | 180.8 | 221 | 211.5 | 221 |
| 5 | Calif. | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Eldorado | 78.2 | 71.8 | 78.2 | 63.1 | 85.0 | 37.1 | 85.5 | 43.7 | 86.1 | 86.5 | 86.1 | 64.1 | 86.1 | 42.2 | 86 | 53.9 | 93 | 138.0 | 93 | 119.8 | 96 | 68.4 | 116 |
| | | Klamath | 114.3 | 31.2 | 114.3 | 57.2 | 137.0 | 70.6 | 140.0 | 88.1 | 170.0 | 150.4 | 170.0 | 137.4 | 170.0 | 153.3 | 170 | 185.2 | 171 | 194.7 | 171 | 177.8 | 183 | 170.3 | 185 |
| | | Lassen | 99.5 | 86.1 | 99.5 | 85.8 | 99.0 | 76.3 | 99.0 | 93.5 | 99.5 | 72.3 | 99.5 | 78.8 | 99.5 | 87.0 | 101 | 93.7 | 101 | 98.3 | 101 | 66.2 | 95 | 94.3 | 99 |
| | | Mendocino | 69.5 | 9.5 | 69.5 | 17.4 | 68.0 | 24.9 | 68.0 | 35.1 | 68.0 | 47.1 | 68.0 | 36.7 | 68.0 | 70.4 | 69 | 77.6 | 69 | 58.1 | 75 | 58.4 | 76 | 90.9 | 81 |
| | | Modoc | 44.5 | 74.6 | 44.5 | 37.9 | 44.0 | 51.4 | 44.5 | 52.2 | 44.5 | 44.3 | 44.5 | 38.0 | 44.5 | 47.3 | 44 | 54.6 | 44 | 56.4 | 51 | 35.6 | 51 | 35.6 | 51 |
| | | Plumas | 159.7 | 135.2 | 159.7 | 102.2 | 140.0 | 106.1 | 140.0 | 110.2 | 183.5 | 180.4 | 184.0 | 118.8 | 183.5 | 125.2 | 160 | 179.6 | 160 | 166.2 | 160 | 141.6 | 169 | 141.0 | 183 |
| | | Sequoia | 55.0 | 31.4 | 55.0 | 35.4 | 55.0 | 30.3 | 80.0 | 29.8 | 79.0 | 41.4 | 79.0 | 68.2 | 85.0 | 39.5 | 85 | 45.8 | 92 | 45.4 | 86 | 37.0 | 86 | 34.3 | 101 |
| | | Shasta-Trinity | 173.1 | 70.5 | 173.1 | 72.7 | 191.0 | 64.2 | 197.0 | 88.8 | 195.7 | 119.3 | 195.7 | 122.6 | 195.7 | 124.1 | 194 | 166.2 | 205 | 289.9 | 204 | 173.5 | 218 | 172.3 | 218 |
| | | Sierra | 87.5 | 25.4 | 87.5 | 35.3 | 81.0 | 40.8 | 82.0 | 46.8 | 82.0 | 65.0 | 38.4 | 75.7 | 38.4 | 62.3 | 87 | 86.5 | 87 | 117.7 | 87 | 95.5 | 91 | 122.8 | 114 |
| | | Six Rivers | 108.2 | 18.1 | 108.2 | 57.9 | 137.0 | 29.1 | 140.4 | 49.4 | 163.0 | 85.2 | 163.0 | 82.9 | 163.0 | 40.4 | 163 | 123.4 | 163 | 115.6 | 163 | 72.5 | 162 | 88.9 | 156 |
| | | Stanislaus | 85.5 | 47.4 | 85.5 | 55.8 | 78.0 | 44.6 | 78.0 | 79.4 | 79.0 | 67.1 | 79.0 | 57.0 | 92.0 | 59.7 | 92 | 84.4 | 92 | 96.3 | 94 | 129.5 | 102 | 91.0 | 123 |
| | | Tahoe | 95.0 | 55.0 | 95.0 | 42.8 | 78.0 | 50.5 | 78.0 | 87.5 | 78.5 | 79.9 | 73.5 | 61.8 | 85.0 | 62.3 | 85 | 95.7 | 85 | 99.9 | 95 | 202.9 | 109 | 184.9 | 130 |
| | TOTAL | | 1,170.0 | 656.2 | 1,170.0 | 663.5 | 1,193.0 | 632.4 | 1,232.4 | 806.5 | 1,328.8 | 1,038.9 | 1,335.7 | 942.0 | 1,360.7 | 919.7 | 1,336 | 1,246.6 | 1,362 | 1,476.5 | 1,380 | 1,310.3 | 1,438 | 1,294.7 | 1,557 |
| 6 | Oreg. | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Deschutes | 81 | 45.1 | 81 | 83.4 | 81 | 89.9 | 98 | 92.4 | 98 | 102.4 | 98 | 128.5 | 140 | 112.9 | 140 | 172.0 | 140 | 184.9 | 140 | 122.0 | 136 | 146.1 | 136 |
| | | Fremont | 86 | 80.0 | 86 | 89.8 | 89 | 101.0 | 89 | 100.8 | 89 | 110.6 | 89 | 93.5 | 100 | 104.8 | 100 | 143.4 | 108 | 106.5 | 108 | 69.0 | 126 | 100.4 | 126 |
| | | Malheur | 93 | 79.1 | 93 | 79.4 | 193 | 64.7 | 105 | 134.7 | 98 | 112.8 | 102 | 102.9 | 106 | 91.9 | 120 | 102.6 | 120 | 136.6 | 120 | 118.5 | 138 | 159.5 | 171 |
| | | Mt. Hood | 243 | 146.9 | 243 | 197.6 | 243 | 206.9 | 278 | 223.8 | 284 | 269.9 | 284 | 237.8 | 311 | 205.7 | 312 | 346.7 | 315 | 365.8 | 315 | 315.6 | 315 | 336.7 | 315 |
| | | Ochoco | 83 | 71.6 | 83 | 99.3 | 87 | 81.3 | 87 | 85.7 | 87 | 91.0 | 87 | 61.4 | 87 | 42.8 | 96 | 106.9 | 96 | 134.4 | 96 | 88.8 | 96 | 119.7 | 98 |
| | | Rogue River | 103 | 80.6 | 103 | 109.2 | 103 | 106.5 | 103 | 136.5 | 103 | 106.0 | 103 | 105.1 | 117 | 121.0 | 117 | 196.4 | 127 | 170.0 | 180 | 189.2 | 135 | 189.0 | 126 |
| | | Siskiyou | 78 | 66.5 | 78 | 60.0 | 153 | 55.0 | 153 | 74.5 | 153 | 88.4 | 153 | 83.3 | 153 | 92.1 | 153 | 155.1 | 153 | 228.8 | 153 | 144.3 | 185 | 178.0 | 179 |
| | | Siuslaw | 188 | 79.6 | 183 | 122.9 | 183 | 129.2 | 185 | 182.4 | 185 | 177.2 | 189 | 206.0 | 189 | 221.3 | 305 | 334.0 | 315 | 355.7 | 315 | 307.5 | 315 | 335.3 | 327 |
| | | Umatilla | 63 | 28.3 | 71 | 27.9 | 71 | 18.7 | 71 | 39.0 | 71 | 33.0 | 71 | 46.1 | 71 | 56.5 | 71 | 67.6 | 71 | 89.0 | 100 | 105.4 | 110 | 89.1 | 129 |
| | | Umpqua | 264 | 163.9 | 264 | 153.3 | 264 | 199.8 | 264 | 250.1 | 264 | 246.9 | 264 | 263.0 | 302 | 197.9 | 303 | 283.8 | 303 | 377.5 | 303 | 297.0 | 303 | 315.3 | 340 |
| | | Wallowa-Whitman | 70 | 33.5 | 70 | 54.4 | 72 | 57.6 | 61 | 66.4 | 61 | 79.8 | 87 | 102.0 | 87 | 88.9 | 87 | 126.9 | 110 | 126.2 | 121 | 110.0 | 121 | 115.3 | 160 |
| | | Willamette | 342 | 280.2 | 361 | 422.5 | 361 | 420.6 | 361 | 381.5 | 361 | 394.4 | 377 | 420.3 | 393 | 404.8 | 499 | 516.4 | 529 | 578.9 | 529 | 549.1 | 529 | 715.8 | 566 |
| | | Winema | --- | ----- | --- | ----- | --- | ----- | --- | ----- | --- | ----- | --- | ----- | --- | ----- | --- | ----- | --- | ----- | --- | ----- | 90 | 75.5 | 90 |
| | Wash. | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Gifford Pinchot | 238 | 41.0 | 238 | 183.3 | 238 | 186.9 | 313 | 196.6 | 313 | 236.0 | 313 | 240.3 | 395 | 205.6 | 397 | 332.2 | 395 | 440.0 | 395 | 425.6 | 395 | 415.2 | 395 |
| | | Mt. Baker | 140 | 107.2 | 140 | 135.1 | 140 | 134.6 | 140 | 130.3 | 140 | 140.8 | 215 | 168.1 | 225 | 175.7 | 222 | 208.6 | 222 | 256.9 | 222 | 239.3 | 201 | 244.2 | 201 |
| | | Okanogan | 56 | 143.2 | 56 | 50.9 | 55 | 56.7 | 48 | 61.7 | 47 | 47.9 | 48 | 61.2 | 48 | 58.1 | 47 | 70.6 | 48 | 76.0 | 48 | 56.2 | 70 | 66.5 | 90 |
| | | Olympic | 248 | 204.8 | 248 | 407.0 | 248 | 362.8 | 305 | 329.4 | 305 | 272.7 | 305 | 270.6 | 339 | 266.2 | 346 | 287.1 | 346 | 317.9 | 341 | 216.4 | 341 | 252.0 | 341 |
| | | Snoqualmie | 161 | 103.0 | 161 | 119.7 | 162 | 91.1 | 162 | 89.6 | 162 | 77.2 | 162 | 111.9 | 197 | 106.7 | 201 | 104.0 | 206 | 146.1 | 206 | 133.3 | 207 | 203.1 | 207 |
| | | Wenatchee | 58 | 39.1 | 58 | 46.4 | 58 | 51.6 | 67 | 57.6 | 76 | 45.8 | 76 | 68.4 | 86 | 63.1 | 94 | 96.3 | 94 | 103.5 | 107 | 90.2 | 107 | 106.2 | 106 |
| | TOTAL (includes exchange cutting) | | 2,595.0 | 1,793.6 | 2,617.0 | 2,442.1 | 2,801.0 | 2,414.9 | 2,890.0 | 2,633.0 | 2,397.0 | 2,632.8 | 3,023.0 | 2,775.4 | 3,340.0 | 2,616.0 | 3,610 | 3,650.6 | 3,698 | 4,194.7 | 3,799 | 3,577.4 | 3,920 | 4,156.9 | 4,103 |
| | GRAND TOTALS | | 4,383 | 2,863 | 4,405 | 3,652 | 4,714 | 3,707 | 4,879 | 4,399 | 5,000 | 4,707 | 5,225 | 4,742 | 5,783 | 4,405 | 6,029 | 5,895 | 6,163 | 6,848 | 6,429 | 5,936 | 6,651 | 6,653 | 7,159 |

1/ Allowable cut given as of January 1 preceding beginning of each fiscal year as sales are financed and programmed on this basis for the following fiscal year.